An issue to mark the
occasion of the
100th Anniversary
of the founding of the
Botanic Gardens, Singapore

THE

GARDENS' BULLETIN

SINGAPORE

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Botanic Gardens, Office and Herbarium

Palm Valley

VOLUME XVII 5TH DECEMBER, 1959 PART II

THE GARDENS' BULLETIN SINGAPORE

AN ISSUE TO MARK THE OCCASION OF THE
HUNDREDTH ANNIVERSARY
OF THE FOUNDING OF THE
BOTANIC GARDENS, SINGAPORE
1859 – 1959

History does not record the exact date. The nearest one can get is that the period of formation was between the first half of November 1859, when a body of citizens was formed with the express purpose of establishing a garden, and 1st January, 1860 when the first subscription became valid.

History and Functions of Botanic Gardens with Special Reference to Singapore

By J. W. PURSEGLOVE

Director of the Botanic Gardens, Singapore (1954–57)

MANY PEOPLE THINK of botanic gardens as public parks in which to stroll amid pleasant surroundings and admire beautiful and rare flowers. Others consider them a convenient exercising ground for the baby or the dog, a good place for picnics, and, in Singapore, somewhere to feed the monkeys.

Definition of Botanic Gardens

Any public park can provide these amenities. Why then go to the expense of maintaining botanic gardens with their staff of botanists, horticulturists and other specialists? The answer is that botanic gardens, to merit the name, are gardens maintained for the scientific study of the plants. As soon as this vital function is neglected botanic gardens change to public parks. This has been the fate of many botanic gardens throughout the tropics, while others have been totally neglected or have disappeared. It is true that they sometimes sell or give away planting material of fruit trees and ornamental plants, but this function can be undertaken by agricultural stations or commercial nurseries.

Botanic or Botanical

Some gardens such as Kew and Singapore are proud of the name Botanic Gardens, all too frequently called Botanical Gardens by the public, while others, especially in America, style themselves Botanical Gardens. Why is this? Botanic is the older form of adjective, but is now mostly superseded by botanical, except in the names of institutions founded long ago. It is advisable to ascertain which adjective is used by any particular gardens in order not to give offence. Some such as the Royal Botanic Garden, Edinburgh, do not use the plural of the noun.

The first Botanic Gardens

The oldest botanic gardens in existence today are those of Pisa in Italy founded in 1543, closely followed by Padua. They were founded by the Universities and were herb gardens in which the

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future physician was taught the medicinal use of herbs and how to recognize them. The Jardin des Plantes was founded by Louis XIII in Paris for this same purpose in 1626, as was the Oxford Botanic Gardens by the University in 1632, and the Chelsea Physic Garden in 1673 by the Apothecaries Society.

Systematic study of plants

In the eighteenth century Linnaeus laid out a garden showing his new system of classification and the plants were labelled in accordance with his binomial nomenclature. Other gardens followed suit and were designed to illustrate a purely scientific concept. Living plants, as well as herbarium specimens, were brought from all over the world for study in temperate countries. Botanists were often attached to voyages of exploration to collect and bring back this material. Many of the famous gardens of Europe, including the Kew Royal Botanic Gardens, founded in 1759, carried out these early taxonomic studies. (The first Botanic Gardens in the United States were not founded until the nineteenth century.) The herbaria and libraries which are so essential for this work were accumulated and the systematic study of plants, sometimes on a local basis, sometimes on a world basis, is still one of the most essential functions of modern botanic gardens.

Founding and work in the early tropical Gardens

As far as I can ascertain the oldest botanic gardens in the tropics are those of Pamplemousses in Mauritius which were established by the French in 1735. Hart's (1919) history of these gardens makes fascinating reading and is typical of many tropical gardens elsewhere. They started as a pleasure garden, although cassava was first introduced as early as 1736. After periods of neglect their principal function was to obtain, grow and distribute seeds of economic plants, particularly of spices, hitherto only cultivated by the Dutch in the Moluccas. Nutmegs were first introduced in 1765, but died. Among the introductions in 1767 were pepper, cinnamom, fruit trees and other plants yielding dyes and varnishes. Expeditions in 1770 and 1772 brought back nutmegs and cloves. The gardens were laid out in a picturesque manner and planted with native, African, Indian, Malayan and Australian plants. They suffered from subsequent periods of neglect, but later played a prominent part in the founding of the Mauritius sugar industry. They were taken over by the newly-formed Agricultural Department in 1913.

The first British tropical botanic gardens are those of St. Vincent founded in 1764 (Chipp, 1920). Bligh was commissioned to obtain bread-fruit for these gardens from Tahiti and his expedition

ended in the famous mutiny of the *Bounty* in 1787; he was more successful in 1791 and brought back bread-fruit plants to the West Indies. These gardens were abandoned for some 60 years later in their history. Among the other early botanic gardens founded in colonial territories are Jamaica in 1774, Calcutta in 1786, the first of the three Penang Botanic Gardens in c.1796, Buitenzorg (now re-named Bogor) in 1817; Trinidad in 1819, Peradeniya (Ceylon) in 1821 and the first Singapore Botanic Gardens in 1822. Typical of all these gardens is the founding of the first botanic gardens in the north American continent when Charles III of Spain sent a scientific expedition to Mexico in 1781, when "one of its objects was to establish a botanic garden in which instruction should be given in botany and in which the native products of the country should be cultivated and preserved" (Rickett, 1956).

In addition to the very important function of collecting, growing and distributing indigenous and exotic economic crops of promise, as well as seedlings of timber trees, and giving advice to the early planting communities on methods of cultivation and the control of pests and diseases, many of these botanic gardens laid a sound foundation of botanical research in the tropics in the nineteenth century. Many of the early directors were men of outstanding ability and industry. First and foremost they were keen botanists and could not help but be interested in the wild plants growing around them, many of which were as yet undescribed. They made arduous collecting trips into little-known country bringing back living plants for trial in their gardens, as well as large numbers of herbarium specimens. These were exchanged with other institutions throughout the world, and as time went on local floras and monographs of particular groups were prepared. The world owes these great pioneers a considerable debt.

By the second decade of the twentieth century most tropical territories had inaugurated independent agricultural and forestry departments, and much of the work on crops and forest products was handed over to them. Many of the botanic gardens were absorbed into the new agricultural departments, often with disastrous results to the research in botany which they had hitherto undertaken. The rôle of botanic gardens in fostering agricultural development in many tropical countries, usually achieved with very small staff and slender financial resources, is now often forgotten.

The movement of crops in the tropics

I have already shown how botanic gardens played a prominent rôle in the distribution of the principal economic crops grown today in the tropics. It is worth examining the subject a little further. It

has always seemed strange to me that many of the world's major tropical plant products are produced largely in countries far removed from their region of origin, e.g. South American rubber in Malaya and Indonesia, South America cocoa in West Africa, South American quinine in the East Indies, African coffee in Brazil, cloves and nutmegs from the Moluccas in Zanzibar and Grenada respectively, sugar, bananas and limes from South-East Asia in the West Indies, and vanilla from Central America in Madagascar. Obviously this cannot be attributed to any one particular reason and many factors are involved, including economics, available land and labour supply, technical skill in processing, suitability of the crop for plantation or peasant agriculture, etc. Nevertheless, one would have expected that a crop was more suited ecologically to its country of origin than to its new home. I suspect that one of the major reasons is that when a new crop has been introduced without many of its normal pests and diseases, it has more chance of flourishing and giving high yields. Many of the crops are introduced as seeds, which limits the number pests and diseases which they can carry with them, and this is further enhanced by the plant quarantine regulations now enforced in many countries. One can only contemplate what would happen to the Malayan rubber industry if the South American Leaf Blight (*Dothidella ulei*) were accidently introduced.

In this digression I have limited myself to economic crops, but further examples can well be given from food crops, too. Many of the staple crops now grown in parts of tropical Africa are of New World origin, e.g. cassava, sweet potatoes and maize.

The early Penang Botanic Gardens

Ridley (1910a) gives the date of the founding of the first Botanic Gardens, Penang as 1800, although in the same article he states that, soon after the first settlement in Penang in 1786, the East India Company decided to start spice gardens with a view to breaking down the Dutch monopoly of the spice cultivation and trade. A botanist, Christopher Smith, was appointed in 1794 and in 1796 was sent to the Moluccas to collect living plants of nutmegs and cloves. Ridley then adds that by 1800 the Gardens contained 1,300 plants and that they were greatly enlarged in that year, when 15,000 clove and 500 nutmeg trees arrived from Amboina. It thus appears that the first Gardens were begun about 1796 and not in 1800 as is usually stated. Ridley goes on to say that Smith sent in all 71,266 nutmeg plants, 55,264 cloves and large quantities of canary nut, (*Canarium commune*) and Kabong palm, (*Arenga saccharifera*).

This transporting of very large quantities of plants in the tropics was to continue throughout the nineteenth century. Nor was the movement confined to economic crops, as plants of horticultural merit were freely distributed between botanic gardens, while scientific institutions, wealthy patrons, seedsmen and nurseries sent collectors to the far corners of the earth to bring back novelties for their hothouses and for sale. The scale on which the exchanges took place is hardly conceivable today and the expense, difficulty and length of time spent transporting them must have been very considerable.

The first Penang Botanic Gardens were sold in 1806. Raffles founded the second Gardens in Penang in 1820. Ridley states that these existed until 1834, "when Governor Murchison, who took no interest in gardens or agriculture, sold them for 1,250 rupees, because his wife could not get enough vegetables from them to diminish her cook's bill."

HISTORY OF THE SINGAPORE BOTANIC GARDENS

The Singapore Botanic Gardens are the last gardens in the British tropics which function as a separate and self-contained department and have never been under the control of any Agricultural Department, Municipality or University. I now propose to confine my attention to these Gardens and describe some of the work carried out there during their long history.

The first Singapore Botanic Gardens

Shortly after the founding of Singapore in 1819, the founder, Sir Stamford Raffles started the first Botanic Gardens on the Government Hill at Fort Canning in 1822. Nathaniel Wallich, who was visiting Singapore from the Calcutta Botanic Gardens, advised on this project. Raffles introduced nutmegs, cloves and cocoa. These gardens were closed in 1829 on instructions from India to retrench expenditure. They were re-opened later by an Agri-Horticultural Society in 1836, who covered the cost from the sale of nutmegs and cloves growing there. They were finally abandoned about 1846. The principal crops of Singapore at that time were nutmegs and gambier; the former failed because of pests and diseases; the latter was too exhausting to the soil and required large quantities of charcoal for its preparation.

In a recent popular article in a Singapore paper a writer (H.T.S., 1956) says, "When critics carp at British colonialism, they should stop for a moment and ponder on the old circumstance that one of

the first matters which occupied the earnest attention of the founders of Singapore was to find a site for a botanical (*sic*) gardens. No great plan for exploiting the local people was afoot here."

The Second Singapore Botanic Gardens

The First Phase: 1859–1875

In 1859 a new Agri-Horticultural Society was formed in Singapore, the third in the history of the island. The Society was given a grant of some 60 acres of land in Tanglin by the Government on which to found a garden. Convict labour was also provided. Members of the society paid an entrance fee and a monthly subscription, while there were second-class subscribers who might enjoy the use of the gardens by paying a monthly fee. They also raised money by public entertainments. The southern end of the Gardens was probably abandoned gambier land, a haunt of tigers, while the north was still virgin tropical evergreen rain forest, 11 acres of which are still preserved in their original form, a most valuable asset in the centre of a great city. The first object of the committee was to create a pleasure garden with roads, terraces and a band stand, where military bands performed fortnightly, the gardens providing an alternative evening drive to the Esplanade for 'the quality'.

Laurence Niven, who supervised a privately-owned adjoining nutmeg plantation, was employed part-time as Superintendent. He had a fine eye for design and laid out the Gardens much as they are today. As early as 1861, flower shows were organised in the hope of encouraging the local cultivation of vegetables, fruits and flowers. In 1866 the Society purchased a further 25 acres of land and built the present Director's house, as well as constructing the Gardens' lake. This depleted the Society's funds and in 1869 they approached the Government for a further grant, the first being $50 towards Niven's salary in 1866. The second grant was agreed to on condition that the Society should exhibit in the gardens living economic plants. At the same time a small zoo started. (There has been a menagerie at the Jardins des Plantes in Paris since 1794.) By 1874 the Society was in debt and could carry on no longer. They asked the Government to take over their Gardens and their debts and to maintain the Gardens for the benefit of the people of Singapore. Government agreed to do this and in 1875 the management committee asked Sir Joseph Hooker, the Director of the Royal Botanic Gardens, Kew, to recommend a suitably trained candidate for the post of Superintendent, who "was to be a practical, as well as systematic botanist, and to travel in the Malay Peninsula not a little for the purpose of investigating its vegetation". (Burkill, 1918).

Thus the second Singapore Botanic Gardens, which celebrates its centenary in 1959, originating as a little more than a public park, began the second phase of its history and was changed into a working Botanic Garden.

The Second Phase: 1875–1888

Sir Joseph Hooker sent out James Murton, a Kew trained horticulturist. He was energetic and enthusiastic, but unfortunately was very young and little suited for control. He added greatly to the collection of plants growing in the Gardens, both economic and horticultural, from the principal Botanic Gardens in the East, as well as Kew. Kew sent the first live Para rubber seedlings in 1877 (see below).

Under the Raffles Society Ordinance of 1878 the Gardens were legally taken over by the Government of the Colony and vested in Her Majesty the Queen, her Heirs and Successors. In 1879 the Government allocated a further 102 acres of land, now occupied by the University of Malaya, for the cultivation of economic crops, particularly gutta-percha and rubber-producing trees. Also growing in these Economic Gardens at this time were *Cinchona,* arabica and liberica coffee, *Eucalypti, Ipecacuanha,* tea, maize, sugar cane, cola nuts, mahogany, etc. Murton added greatly to the Gardens' menagerie. He collected plants in Singapore and in the Peninsula, but his duplicates in Singapore later disappeared, when he was dismissed in 1880. He died in Bangkok the following year and Burkill (1918) says "his death perhaps hastened by his having burnt the candle at both ends."

Murton was succeeded by Nathaniel Cantley, who was also a Kew trained horticulturist. He had been Assistant Superintendent of the Mauritius Botanic Gardens and was an older man, a great lover of order. He did much planting and named and labelled all the plants in the Gardens. He surveyed the forests of the Straits Settlements and was responsible for gazetting the first forest reserves. He planted large numbers of Malayan and introduced timber trees in the Economic Gardens, and his arboretum was arranged in a botanical sequence on the system of Bentham and Hooker. Cantley was a keen botanist; he collected local plants and started the herbarium. He also experimented with European vegetables. The grounds of Government House Domain were placed under the Botanic Gardens and still remain so today. The Gardens also helped in horticultural work in the city and much of the tree planting in Singapore, which greatly adds to its attraction, was supervised by the Gardens' staff. Cantley, who had never been a very fit man, went on sick leave in December 1887 and died the following year.

The Third Phase: 1888–1912

With the appointment of Henry Nicholas Ridley as Director in 1888 the Gardens entered upon the third stage in their history and a most productive period it was. "Ridley's capability as a research worker and his power to demonstrate by his publications the practical and beneficial effects of photography on plant science in all its aspects . . . succeeded in a surprisingly short time in pushing the Singapore Gardens to the fore as a centre of Malaysian phytography" (de Wit, 1949). Ridley was a tireless worker and his phenomenal output of work in the natural sciences and his application of this to economic problems is quite remarkable.

He has been rightly named "the father of Malaya's rubber industry". His early experiments on the tapping and preparation of rubber and his constant advocacy of it as a plantation crop, often in the face of opposition, led to the foundation of the present industry upon which so large a share of the wealth of Malaya and the eastern tropics has rested (Purseglove, 1955 a). Nor was his work on economic crops confined to rubber; he carried out experiments with most of the actual and potential crops known. As early as 1889 he reported that cocao would probably be profitable on the better Malayan soils, while in 1907 he directed attention to the possibility of oil palm as a plantation crop. The local planting community was largely dependent upon the Economic Gardens for planting material and seeds of economic crops were distributed to all parts of the tropics. In the case of rubber alone, over seven million seeds were distributed from the Singapore Botanic Gardens, as well as many seedlings. The Gardens obtained a considerable income from the sale of these, as well as the rubber produced, thus allowing them to be maintained without any increase in Government vote. Visitors from all over the world visited the Economic Gardens, while Ridley and his three assistants in Singapore, Malacca and Penang, were the only trained men whom the planting community could approach for technical advice and help. It was Ridley who was responsible for and then administered, the *Coconut Trees Preservation Ordinance* of 1890 for the control of the rhinoceros beetle. In addition to being Director of the Botanic Gardens, Ridley was also Director of Forests, Straits Settlements and was responsible for gazetting additional forest reserves. He produced the first published accounts of Malayan timbers, vegetables, fruits, fibres, dyes and drug plants, while his book on *Spices* (1912) is the standard work.

Ridley's work as a field botanist is equally remarkable. He travelled far and wide in the Malay Peninsula, often in remote regions,

as well as visiting Cocos and Christmas Islands, Borneo, Java and Sumatra. On all these expeditions he studied the vegetation and brought back vast numbers of herbarium specimens, as well as many living plants for trial in the Gardens. In all he collected many thousands of specimens, of which a large number were unknown to science. These specimens are now in our herbarium, but duplicates were sent to Kew and other botanical institutions. He named and described for the first time a few thousand plant species and a surprising number are still only known from his original gatherings. Specimens were sent to experts on certain groups elsewhere and many new species were named in his honour. Ridley realised very early in his career that the flora of a country cannot be studied *in vacuo* and that it is essential to take into account plants from neighbouring territories as well. After his retirement he wrote his five-volume *Flora of the Malay Peninsula* (1922–25).

Nor was Ridley's attention confined to plants, of which he collected in all groups. He belongs to that great pre-specialised age of scientific natural history and he collected and studied many animals, as well as distributing specimens and writing about them. Ridley's work as a naturalist has been more fully described elsewhere (Purseglove, 1955 b). He took a keen interest in the Gardens' menagerie, which was disbanded in 1904–5, much to Ridley's obvious regret.

In addition to publishing in many scientific journals in Singapore and overseas, Ridley founded the *Agricultural Bulletin of the Malay Peninsula* in 1891, so that he could supply the planting community and others with information resulting from his many investigations. In all he published over 500 papers, articles and books, totalling over 10,000 printed pages, so that the work of the Singapore Botanic Gardens became widely known throughout the world. Details of his publications and other work will be found in *Gardens' Bulletin, Vol. IX,* 1935, which was dedicated to him on his 80th birthday. Attention should be drawn, however, to his encyclopaedic volume, *The Dispersal of Plants throughout the World,* published in 1930, which still contains much of value for the botanist and the agriculturist.

Few people have accomplished so much in twenty-three years of tropical service as Ridley did—he retired in 1912—nor have completed their work after retirement as he had done. He was elected a Fellow of the Royal Society in 1907 and, apart from the honour of C.M.G. in 1911, he received comparatively little public recognition, until his hundredth birthday, which was celebrated on the 10th December, 1955. On this occasion he wrote "It is a great delight to me to have lived to see the Gardens, the best tropical

Gardens in the world," and that "my hundredth birthday was one of the most enjoyable days of my life". It is with regret that I record the death of Mr. Ridley on the 24th October, 1956.

The founding of Malaya's rubber industry

Accounts of the transfer of Para rubber from Brazil to the eastern tropics have often been given, but frequently they are inaccurate in detail. As the Singapore Botanic Gardens played such an important part in this introduction, it is worthwhile recording briefly the facts at this juncture.

Sir Clement Markham of the India Office, who had been responsible for bringing *Cinchona* from South America to the east in 1865, pointed out in 1870 that there was a danger of exhausting the Indo-Malaysian supply of wild rubber and recommended that plantations should be put down in the east. James Collins, who was Government Economic Botanist and Librarian in Singapore, was asked to collect all the available information about rubber-producing plants and his report was published in 1872. Through Markham's efforts and those of Sir Joseph Hooker, the Director of Royal Botanic Gardens, Kew, a few seeds were collected and sent to Kew in 1873, when a dozen plants were raised. Six of these were sent to the Calcutta Botanic Gardens and were later propagated and sent to Sikkim, where they were a failure, the climate being unsuitable. A consignment of seeds was sent to India in 1875 and failed to germinate.

Markham then arranged for Robert Cross to collect rubber seeds in South America, while Hooker obtained the services of H. A. Wickham, later Sir Henry, who was then on the Amazon. Wickham collected 70,000 seeds. He did not smuggle the seeds out as is often suggested; it is now known that they were brought out with the goodwill and co-operation of the Brazilian Government. Wickham chartered a ship and the seeds arrived at Kew on 15th June, 1876, where they were planted immediately. Less than 4 per cent germinated and some 2,800 seedlings were raised at Kew. Many large tropical oily seeds retain their germination powers for short periods only and it was Ridley who later discovered that they could easily be transported in damp powdered charcoal. On 9th August, 1876 Kew sent 1,919 plants to Ceylon in 38 Wardian cases. Two days later 50 plants were sent direct from Kew to Singapore. Thiselton-Dyer (1878), and later quoted by Ridley (1910b), states that "owing to the delay in payment of freight (in Singapore) these plants all perished". Burkill (1935) says that Murton reported that "five plants were alive when the cases were received at the Gardens", although they appeared to have perished subsequently.

On 10th June, 1877 Kew sent a further 22 plants direct to Singapore and these thrived. They were not sent from Ceylon as is often published.

In the meantime Cross returned to England with a consignment of plants in November, 1876. Burkill (1935) states that "not one of Cross's plants collected in Para is known to have survived the seedling stage or to have reached the east". This was good fortune in disguise as the east was stocked from Wickham's seeds, which were collected in the central valley of the Amazon, where the trees are now known to have been of better quality than those nearer the mouth. Murton planted eleven of the rubber plants near our present nursery and then Fox in 1879 transferred them to swampy ground in the new Economic Gardens, as it was thought that this was the natural habitat of the tree. He took nine of his seedlings to Perak in October 1877 and these were planted at the Residency at Kuala Kangsar. Most of the rubber in Malaya has come from this original introduction, although some seeds were received from Ceylon at a later date.

The Singapore trees first fruited in 1881. When Ridley arrived in 1888, there were 9 trees of the original introduction, some 50 trees 2–4 years old and over 1,000 young seedlings. He quickly planted more. The subsequent exploitation and establishment of rubber as a plantation crop in Malaya was due almost entirely to Ridley. Within four months of his arrival in Singapore he drew the Government's attention to this possibility. With great perseverance, little encouragement or help and slender financial resources, he set to work. He has since recalled how he was "carpeted by the Governor, Sir Frank Swettenham, who admonished him to waste less time on an uneconomic product such as rubber." He experimented with various rubber-producing trees and found that *Hevea* was superior to all others. Starting with a mallet and chisel, and later using a modified farrier's knife, he developed the tapping technique which has been but little changed since. He discovered wound response, which he terms "calling the rubber", and he also demonstrated that the bark regenerated and could be tapped again. He exhibited coagulated rubber in Singapore in 1890 and the following year sent specimens to England which were well reported on.

Having shown that rubber was a commercial proposition, Ridley then tried to persuade the reluctant planters to give the new crop a trial, but at first met with little success, as coffee was considered to be the only important crop in Malaya. For his efforts he was known as "Mad Ridley". In 1893 he distributed the plants and seeds to Residents and District Officers in the Federated Malay States to plant near their houses. It was fortunate for Malaya that

when rubber planting began in earnest—coffee prices had slumped and the trees had ben attacked by diseases and pests—that there was at the Singapore Botanic Gardens a good supply of planting material and Ridley, the expert, with the latest 'know-how' to advise and to help planters. Ridley stayed long enough in Singapore to see the great rubber boom in 1910 and for Malaya to reach a predominant position in world rubber production, which it has never lost.

The Fourth Phase: 1912–41.

During Ridley's term of office the Gardens established for themselves an international reputation, which was adequately maintained during the next stage in its history. With the forming of the new Agricultural Department in 1904, much of the work on the economic crops passed from the Gardens and the Economic Gardens were finally closed in 1925. Gradually during the period more staff were recruited, especially botanists, so that the work on taxonomy could be extended. Some work was done on the lower plants, particularly the Fungi. In the horticultural field the hybridising of orchid and other cultigens was undertaken.

I. H. Burkill, who had been on the staff of the Calcutta Botanic Gardens and had collaborated with Watt on the study of the economic products of India, was appointed Director in Singapore in 1912. During World War I the Gardens were understaffed and there was little time for expeditions and collecting. Anderson's *Catalogue of Plants growing in the Gardens* was published in 1912 and lists 1739 species, which included 276 orchids, 261 ferns and 245 palms. T. F. Chipp was appointed Assistant Director in 1915, a new post having been created, but he did not take up his duties until 1919. He was transferred to West Africa at the end of 1920, in which year he published his *List of the Fungi of the Malay Peninsula.* Until the Economic Gardens were taken over by Raffles College, now the University of Malaya, in 1924–25, they continued to play an important role in the distribution of economic plants. In 1916 two hundred species were listed as available for sale at the Gardens. The loss of the Economic Gardens was a grievous blow, as the land available for planting was more than halved.

Burkill continued his interest in medicinal and economic plants generally and collected much information on these in Malaya. He continued this work for 10 years after retirement and published in 1935 his large two-volume *Dictionary of the Economic Products of the Malay Peninsula,* a work of great scholarship, "a masterpiece of synthesis", and a model for all works of this type. It is of great value to the botanist and the agriculturist, not only in Malaya, but

throughout the tropics. Unfortunately it is now out of print, but I hope that it may be reprinted soon. Burkill also made a detailed study of the genus *Dioscorea* (yams), a genus on which he is still working.

The Gardens Committee ceased to have their own banking account in 1919 and their balance was paid into the Treasury. Thereafter the Government increased the Gardens' vote, which was provided under several separate heads, where formerly a lump sum had been given.

R. E. Holttum was appointed Assistant Director in 1922. He was promoted Director in 1925 and continued in this post until 1949, when he became the first Professor of Botany in the University of Malaya. Holttum's principal interest were ferns and monocotyledons and he added greatly to our knowledge of these plants, describing many new species. He showed that wild orchids may hybridise and produce 'species' which had hitherto never been suspected to be of hybrid origin (de Wit, 1949). He began work in 1928 on the production of spectacular new free flowering hybrids of cultivated orchids and this work is still being continued at the Gardens.

C. X. Furtado joined the staff in 1923 and is still Botanist here. During this period he has become an acknowledged authority of the International Rules of Botanical Nomenclature and on Malaysian palms and aroids.

M. R. Henderson was appointed Curator of Herbarium in 1924 and held this post until he was appointed Assistant Director in 1946 and Director in 1949. He worked on Malayan flowering plants generally, his special interest being limestone plants and the family Myrtaceae.

E. J. H. Corner arrived in Singapore in 1929 as Assistant Director, the post which he held until 1946. He specialised in Fungi and trees and carried out research on the morphological and ecological aspects of the vegetation. Corner trained *berok* or pig-tailed monkeys (*Macacus nemestrina*) to collect botanical specimens, thus partly solving the problem of obtaining specimens from tall trees and climbers otherwise inaccessible. Corner states that one of these monkeys knew the meaning of 18 words of Malay and was able to find at the tree tops fruits and flowers which had been shown to him on the ground. It has been said that these botanical monkeys were "the first apes to enter Government Service". Corner's two-volume *Wayside Trees of Malaya* was published in 1940, a work full of out-of-the-way information and original observations and is one of the most fascinating books ever produced on the trees of

any country. Corner, now Lecturer at Cambridge University, is continuing his study of the genus *Ficus* in Malaysia.

Mention must also be made of C. E. Carr, a Malayan planter, who worked in conjunction with the Gardens, and added greatly to our knowledge of Malaysian orchids. He died in New Guinea in 1936 when returning from a collecting expedition.

From 1923 to World War II the senior staff of the Gardens consisted of Director, Assistant Director, Curator of the Herbarium and Assistant Botanist, all actively engaged on botanical research and three horticulturists as Curators, two in Singapore and one in Penang. In Singapore one Curator supervised the horticultural work at the Gardens and the other looked after Government House Domain and the outside commitments in the City.

The Gardens' collection of living plants and the herbarium were added to greatly during this period.

The Fifth Phase: The Japanese Interregnum: 1942–46

During the early years of the World War II before the Japanese attacked Malaya at the end of 1941, most of the senior Garden staff were seconded for at least part of their time to the Department of Food Control and Information. The Gardens maintained demonstration plots of vegetables to encourage local production. J. C. Nauen and G. H. Addison, Curators at Penang and Singapore, were mobilised with the local defence force and were later taken prisoners and sent to work on the Siam-Burma railway, where Nauen lost his life. Holttum, Corner and Furtado remained in Singapore during the occupation and were permitted to carry on with their botanical research. Immediately following the capture of Singapore Island, Professor Tanakadate, of Tohoku University, took over the control of the Gardens, and took care that they were not despoiled by the Japanese military forces. Holttum remained in executive charge until the appointment of Professor Kwan Koriba, of Kyoto University, as Director of Gardens in December 1942.* During his stay in Singapore Koriba undertook research on the growth-behaviour of some Malayan trees. It was particularly fortunate for the Singapore Botanic Gardens that the Japanese scientific officers and the British staff who remained were able to preserve the herbarium and the library as part of the cultural heritage of Malaya and that no loss whatsoever was suffered in them, except for a few specimens which were on loan in Germany. Losses did occur, however, among the living collection and garden work deteriorated generally, as more than half of the out-door staff (49 men)

* An orbituary of Professor Kwan Koriba is published in this Bulletin. *Editor.*

were sent to work on the Siam-Burma Railway, where 22 of them lost their lives. There was comparatively little damage in the Gardens, although the Director's house received a direct hit from a shell, but, even so, the damage was not serious.

From September 1945 to March 1946 the Gardens came under the British Military Administration.

The Sixth Phase: 1946–56

After the war the staff was gradually re-assembled, but did not reach its full compliment until the end of 1954, M. R. Henderson was appointed Assistant Director and later Director (1949–54). J. Sinclair arrived in 1948 as Curator of the Herbarium, the title later being changed to Keeper. J. W. Ewart, Horticultural Curator, served as Agricultural Officer, Singapore, as well as carrying out his duties at the Gardens. Henderson retired in 1954 and J. W. Purseglove was appointed Director, while H. M. Burkill (son of I. H.), was appointed Assistant Director in December of that year.

Gradually during this period the Gardens were brought back to their former good condition, the living collection of plants was increased and collecting in Malaya and Borneo was resumed. The first two volumes by R. E. Holttum of the *Revised Flora of Malaya* were published. Burkill has begun a study of Malayan seaweeds.

On the 10th December, 1955, the Gardens celebrated the hundredth birthday anniversary of H. N. Ridley, with an exhibition of Ridleyana and current work, while the Gardens were floodlit for one week. A special brochure for private circulation was produced for the occasion (Purseglove, 1955c).

Early in 1955 a scheme was drawn up in conjunction with the University of Malaya with the aim of attracting research workers from Britain and elsewhere to Singapore for one or two years to carry out the botanical research in their specialised fields. By this means the output of research would be increased and knowledge would be obtained which would be of great value to the tropics as a whole. Furthermore, workers from temperate countries would become familiar with tropical botany and their interest in our problems would be stimulated. In 1955 P. B. Tomlinson of Leeds University was awarded an Agricultural Research Council Scholarship and spent one year here studying the anatomy of palms. T. C. Whitmore, a Ph.D. student of Cambridge University, arrived in December 1956 to spend a year working on the anatomy of Dipterocarp barks in relation to taxonomy. He is receiving a Colonial Development and Welfare grant. It is hoped that more research workers may come in the future.

[*In order to bring this paper up-to-date as a history of the first hundred years of the Botanic Gardens, the footnote below headed:* **The Seventh Phase: 1957 and on,** *has been added to the original paper in concurrence with the author.*—EDITOR.]

Waterfall Garden, Penang

The third Botanic Gardens in Penang were founded by Charles Curtis in 1884 as "a nursery for the planting of colony products", and were under the charge of the Gardens and Forest Departments Straits Settlements, with its headquarters at the Singapore Botanic Gardens. Curtis, who had been employed as Messrs. Veitch's plant collector in Mauritius, Madagascar and Malaysia, was appointed Superintendent and remained there until his retirement in 1903. Holttum (1934) records that Curtis "was an enthusiastic plant-lover and a born gardener, and the development of the Waterfall Garden is a monument of his energy and skill". Curtis also made large collections of herbarium specimens in Northern Malaya. The Penang herbarium was later incorporated with that at Singapore.

The Seventh Phase: 1957 and on.

The penultimate constitutional step in the introduction of full internal autonomy of Singapore (effected in May 1959) was operative from April 1955. As befits a country in charge of its own affairs, the Singapore Government adopted a policy of "malayanisation" of the public service from January 1st, 1957. J. W. Ewart retired in March 1957 in accordance with this policy, and A. G. Alphonso, who had returned in 1956 from a two year course of training in horticulture at the Royal Botanic Gardens, Kew, England, was promoted Curator. J. W. Purseglove retired voluntarily in March 1957, and H. M. Burkill became Director. G. H. Addison retired in February 1959. Chew Wee Lek was appointed Botanist in 1956 and went to Cambridge, England, in 1957 for three years to study for a higher degree. Lam Hin Cheng was appointed Horticultural Assistant in July 1957 and went to the Royal Botanic Gardens, Kew, for a two year course in horticulture. The new post of Librarian was eventually filled in April 1958, and Tan Kim Ho went to Melbourne, Australia, in 1959 for training in library management on an Australian Government award under the Colombo Aid Programme. Attempts to fill the post of Assistant Director were unavailing, and finally Miss Chang Kiaw Lan was appointed Botanist (vice Assistant Director) to take up a study of mycology. In 1958 Bajuri bin Sappan, Laboratory Assistant, was sent to various institutions in England for one year to study plant breeding techniques with a view to furthering the Department's plant breeding work.

The last three years, 1957 to this centenary year of 1959 have been a period of transition characterised by an acute shortage of senior personnel through loss of qualified staff and temporary loss of the services of officers sent overseas for training. The most severe effects of this will be over by the end of 1959, when only one officer remains overseas, and he will be back in 1960. Thus will close a century of expatriate know-how in the senior botanical and horticultural posts, and there will open the second century of the Gardens' history, every bit as promising in the comity of international botany as the first has been successful, with the majority of the senior posts held by Malayan personnel. *H.M.B.*

In 1910 it was decided to convert the Gardens into a reservoir, but fortunately this did not materialise. With the formation of the Malayan Union in 1945, later renamed the Federation of Malaya, and the separation of Singapore as an individual colony, the control of the Waterfall Gardens passed from the Singapore Botanic Gardens to the Federation Agricultural Department. This was a great loss to the Singapore Gardens as the climate of Penang is more seasonal than that of Singapore and was therefore better suited for the growth of certain plants, which flower and fruit there, but will not do so in Singapore. Furthermore, the Penang Gardens lost the stimulus of direct contact with the parent institution where botanical research is carried out.

THE WORK OF BOTANIC GARDENS

The principal work carried out by botanic gardens can be divided under three broad heads, namely, botanical, horticultural and educational, although inevitably there is some overlapping between them. In addition to these functions most botanic gardens are opened to the public and thus provide the facilities of a public park. For this purpose they should be laid out as attractively as it is possible to make them, without jeopardising the work of the scientific study of plants. The Singapore Botanic Gardens are opened to the public from 6 a.m. until 7 p.m. daily; no charge is made and the popularity of the Gardens can be gauged from the very large number of visitors to them. Most tourists visiting Singapore also come to see the Gardens.

I now propose to give a more detailed account of the work under the various heads given above, illustrating this from the Singapore Botanic Gardens.

BOTANICAL WORK

The living collection

A botanic gardens should have as large a collection of living plants as it is possible to grow, without sacrificing an attractive layout. In fact a Gardens should be a great museum of living plants. All the plants should be correctly labelled with their scientific name and family, together with the country of origin. If there is a common English or vernacular name, this may be added, but this is often difficult when various languages are spoken as in Singapore. Care should be taken to keep the names up-to-date according to the latest nomenclature changes. As many different groups of plants as possible should be represented. Inevitably, certain gardens specialise in certain groups, particularly those on which specialists have

been working. Thus in Singapore our collection of palms, orchids and ferns are particularly good. Inevitably many plants of botanical interest, but of little value horticulturally, must be included in a botanic gardens, and they are not always as colourful as the layman expects. It is desirable that closely related species or even groups, should be planted near each other, which is very useful for comparative purpose, but this should not be carried to the extreme, as it results in a deterioration in the lay-out. Herbs and woody plants of varying stature, although belonging to the same family, are often difficult to grow together and to maintain and are unsightly when so planted. A lot of plants can be grown in pots. For this a burnt earth-compost mixture has proved to be the most suitable for our conditions for many plants. This method is described by Holttum (1953 a).

The Singapore Botanic Gardens have some 3,000 perennial species growing in them at present and this does not include hybrids. Even so, there is a limit to the number of plants that can be grown in our eighty-five acres and there is little room for further planting, particularly of large trees. The work of labelling such a large collection presents difficulties and label printers are constantly at work repainting old labels and preparing new ones. The majority of our labels are made of wood or metal, 6″ × 4″, with an iron prong 8″ long for sticking in the ground. They are painted black with the plant name clearly printed in white. For pots and small species printed aluminium labels are used. These are also attached to trees in the Gardens' jungle, but unfortunately they are often removed by monkeys.

The Herbarium

In addition to the living collection, a botanic garden should have a *hortus siccus*—the herbarium, or at least one reasonably accessible to it. In this, dried mounted specimens are preserved. The Singapore Herbarium is situated in the Gardens and has over 400,000 sheets. The specimens are mainly confined to plants of the Malaysian region, which extends from Sumatra and Malaya to New Guinea, but there are a few from surrounding countries. Our oldest specimens are over 150 years old and are still in a good state of preservation, despite the fact that they are housed in wooden cupboards and the building is not air-conditioned, although the latter is preferred if possible. The collection is arranged according to the Bentham and Hooker system, and, within the species folders, according to the various Malay states, Malay islands and exotics. There is also a smaller and separate Gardens' Herbarium of cultivated plants.

In addition to being in constant use by the botanists, both at the Gardens and the University, the specimens are sent on loan to botanical institutions elsewhere for study. In 1956 a total of 4,525 sheets were sent on loan, mainly to Leiden, Bogor and Kew, to authors of the *Flora Malesiana,* while 4,903 sheets were sent on loan in 1955. The value of the specimens is enhanced considerable when the sheets are returned correctly annotated. Inevitably some mixing occurs in folders until the genus has been currently revised, but this is not peculiar to Singapore.

There is also a good collection of spirit material, particularly of orchids, and this is invaluable for detailed study.

Collecting, naming and distribution of specimens

Both the living and dead collections of plants at the Botanic Gardens are added to constantly by collection, donations and exchange. Plants do not recognize political boundaries and in studying the plants of a country such as Malaya, it is essential to study the plants of surrounding countries, if one is to understand the variation and distribution of the local species. Thus botanists from the Singapore Botanic Gardens, although the bulk of their collection has been made in Malaya, have also collected extensively in Borneo and to a lesser extent elsewhere, where the flora shows regional affinities. We also try to collect as many duplicates as possible of each gathering, so that these may be distributed to other institutions elsewhere. In these uncertain days spacial separation of duplicates is very desirable, so that if one or more sets are destroyed, as happened in Berlin and the Philippines during the war, others are available elsewhere. 5,397 duplicates were distributed from Singapore in 1956, many of which were plants collected by the writer in Sarawak. 6,768 duplicates were received, of which a large portion came from the Forestry Departments of Sarawak, Brunei and British North Borneo. Many of these were unnamed and have since been determined by the staff. Private collectors are also encouraged to send in specimens.

The importance of adequate field data on all specimens cannot be over-stressed. Each specimen should be given a serial number and notes are made of the place of collection, habitat, altitude, relative abundance, as well as information on habit, colour of flowers, etc., which cannot be ascertained from the dried specimens. Special herbarium labels are provided for listing this data. In the past this type of information, which can be of very great value to the taxonomist, was frequently neglected. Sterile material is often of doubtful value.

With the aid of a good modern flora, a botanist should be able to determine most of his specimens in the field—but unfortunately how many tropical countries have complete up-to-date floras! Even when they are available, certainty can only be reached by comparison with authentic named material. Agricultural and forestry departments, teachers, students, planters and others from Malaya, Borneo and elsewhere send us specimens for determination. Small plant fragments are sometimes sent for identification in connection with police investigations, medical enquiries, etc. We receive frequent requests for information on certain plants. Thus we provide an important service, which cannot be obtained elsewhere in Malaya.

Taxonomic studies

A very important function of any botanic gardens is research in systematic botany. This critical and highly specialised work involves detailed revisions of genera and families and is an essential preliminary to the publication of any flora. Previously named species are critically examined, questions of synonomy are finalised, and new species are described. Furthermore such work can never be completely perfected, as a critical study of the great amount of material collected during the past 40 years reveals large numbers of undescribed species, as well as new information on distribution and variability, while future collecting will yield yet more. It is necessary that the names and descriptions of Malayan plants should be brought into line with those of neighbouring countries. I am convinced that a study of Malaysian plants as a whole is an essential preliminary in the preparation of the local flora. Consequently, the staff of the Singapore Botanic Gardens is now collaborating in the production of the *Flora Malesiana,* edited by C. G. G. J. van Steenis of Leiden University and financed by the Indonesian Government.* This major work will occupy many botanists from many countries for many years.

So much new material and new knowledge has accumulated since the publication of Ridley's *Flora of the Malay Peninsula* in 1922–25, that it is now out-of-date and a *Revised Flora of Malaya* is being prepared. Two volumes have been published so far, both by R. E. Holttum, namely, *Orchids of Malaya* (1953) and *Ferns of Malaya* (1955). This work is designed to be of use to the field

* From 1st January, 1958 funds from this source have ceased. The Flora Malesiana Foundation is currently sponsored by the Netherlands Organisation for Pure Scientific Research "Z.W.O." with contributions from British Government and Commonwealth sources, including Singapore.

Editor.

naturalist and the gardener, as well as the specialist, and includes introduced, as well as indigenous plants.

The great complexity of the Malaysian flora, which is one of the richest in the world, makes the task of the taxonomist a very formidable one. Some idea of this can be obtained if one realises that the island of Singapore, with an area of 225 square miles and a population of one and a quarter million, has some 2,000 indigenous species of plants, a total which is greater than that of the British Isles; the Malay Peninsula has about 10,000 species, while the estimate for the Malaysian region as a whole is 30,000 species.

The taxonomist working in the region whose flora he is describing has the great advantage of being able to study many of the plants in his group living in their natural habitat, which is an invaluable aid to his study of herbarium material. Some of the plants may also be growing in the local botanic gardens. For modern taxonomic study it is essential for the worker to see as many as possible of all the collections that have ever been made of the species he is studying. Thus most herbaria are willing to lend their specimens to experts wherever the latter may be working.

The importance of taxonomic research

The great Linnaeus has said "Science, and in the first place botany, is the only reliable basis of private as well as national economy." Many people would regard this statement as too sweeping; nevertheless taxonomic research is of vital importance to the agriculturist, the forester and other applied scientists, as well as all those who wish to assess and develop the natural resources of a country. Many people fail to realise the importance of giving plants their correct scientific names, so that their results can be understood in all countries regardless of the language used. Their research would often be of greater value if they took the trouble to ascertain the correct names of the plants they are working with, and, in the case of plants not widely known, would lodge authentic specimens at some recognized institution for reference purposes. Anthropologists and others frequently write of plants used by indigenous people as food and medicine and in magic, etc., and are content to give the vernacular names only, thus rendering their work nearly worthless for the botanist, chemist and others, who might well follow it up had they taken the trouble to collect specimens and get them properly identified. I have long felt that there is far too little active collaboration between the agriculturist and the botanist to their mutual disadvantage.

The knowledge of the correct names of plants is essential for the ecologist. I would like to see the collecting numbers of plants

quoted in ecological papers, so that future workers have access to the specimens of which authors have based their results. Some ecological studies have been carried out by the staff of the Singapore Botanic Gardens in the past and I would like to see this extended. I believe that ecological studies in the widest sense provide the only sound basis for the preparation of rational plans of land utilisation.

Botanists from their collections and research discover plants which are closely related to those in cultivation and thus can provide material of great value to the plant breeder. An Indian sugarcane breeder visited Singapore in 1956 and found in our herbarium one sheet of a variety of *Saccharum spontaneum,* which had been collected by Ridley in 1891 in a remote area of Pahang. Travelling by plane, car and boat he was able to obtain planting material of the variety and returned to Singapore within four days.

This section could be extended considerably. I hope I have said enough to convince the Philistines that the plant collecting and taxonomic research carried out by the staff of the botanic gardens has a wider application than is often realised.

HORTICULTURAL WORK

Exchange of Planting material

Most botanic gardens produce an annual *Index Seminum,* or seeds list, which they distribute to other botanic gardens for favour of exchange. As the number of species of which seed is available in Singapore varies but little from year to year, our list is produced at irregular intervals for distribution and is also available on request. We receive lists from all over the world, including most communist countries. In this way a free exchange of planting material is effected, thus enriching the living collection of plants in all countries. In 1955 the Singapore Botanic Gardens sent out 515 packets of seeds and 113 plants on an exchange basis and received 362 packets of seeds and 371 plants, including gifts. 368 packets of seeds and 87 plants were despatched in 1956, while 575 packets of seeds and 185 plants were received. Only a small proportion of the introductions may be really successful in Singapore; nevertheless, our collection of plants is being added to constantly and new plants of horticultural value are available for the country as a whole.

The immediate supply of seeds from the Singapore list cannot be guaranteed as many local seeds are viable for short periods only and stocks cannot be kept in good condition, while many species fruit at irregular or long intervals. Every effort is made to meet requests, however, and lists are kept of requirements and the seeds

Top—Formal Garden, Lawn J

Below—Sun Rockery and Director's Quarters in background

are collected and despatched at the earliest opportunity as they become available. Our current list gives 864 species, some of which are grown in the Gardens, while others are collected in the natural vegetation on the island. Many of the larger seeds of short viability are sent out in damp powdered charcoal or damp coir dust. Germination begins during transit and we receive very favourable reports on palms and other seeds sent out in this way.

In addition to this normal exchange of seeds between botanical institutions, many requests are received for living plants, as well as spirit and fixed material, from specialists elsewhere. Wherever possible it is provided, except for unreasonable requests which would require a major expedition to fulfil or take up too much time. In all this exchange care is taken to see that only authentic material is sent out.

During the past few years a collection of over 400 species of cacti and other succulents has been built up. These grow surprisingly well in Singapore, provided they are sheltered from the rain and receive plenty of sun. They are grown in open-sided houses with glass roofs. Succulents are becoming very popular among local growers.

Members of the staff on collecting expeditions bring back local plants of horticultural value for trial in the Gardens, while friends and correspondents send in similar material. Living material is usually packed in polythene bags, in which it remains fresh for a considerable period. One of the most successful introductions in recent years has been the New Guinea Creeper (*Mucuna bennettii*), which produces hundreds of large spectacular trusses of brilliant flame-coloured flowers several times a year.

Although most of the work on economic plants has been taken over by the Agricultural and Forestry Departments, there is still a good collection in the Singapore Botanic Gardens and new ones of special interest, such as *Rauwolfia* spp., are introduced for trial.

Breeding of Orchids and Other Plants

The seasonless climate of Singapore, with an average annual rainfall of 105 inches per year, a mean temperate of about 80°F. with little diurnal change and a mean relative humidity of 82 per cent, makes it difficult to find plants which will flower regularly and provide colour in the Gardens. The aspect of the natural vegetation is varying shades of green and offers little in the way of good horticultural plants. Consequently, most of the garden plants grown in Singapore have originated in countries other than Malaya and where there are distinct cold or dry seasons. Under our conditions there is no special season of flowering or leaf-fall and individual

plants of the same species adjust themselves quite differently. Consequently, we never get the spectacular bursts of flowering of such trees as *Delonix regia* or *Jacaranda* as can be seen in India or East Africa.

One of the solutions to this problem is the breeding of new varieties of plants suited to local conditions and this work has been actively pursued at the Singapore Botanic Gardens for many years. Although hybridisation has been done in various groups such as *Bougainvillea, Cannas,* etc., by far the most attention has been devoted to orchids. This work was begun in 1929 and has produced very successful and spectacular results. The aid is two-fold, namely, to produce hybrids of horticultural merit and commercial worth and to investigate the relationship between the various groups of orchids. Malaya has some 800 species of indigenous orchids, but only a few of these are suitable for garden plants. By hybridising these, together with imported species from Burma, Java, the Moluccus, New Guinea and the Philippines, a very wide range of free-flowering and beautiful hybrids have and are being produced.

The principal genera used in crossing are: *Arachnis, Dendrobium, Renanthera, Spathoglottis* and *Vanda.* The first Singapore hybrid was Vanda Miss Joaquim raised in 1893, but the bulk of the hybrids now grown have been produced in the last 30 years and many of these since the war. Some 2,800 crosses have been made to date and every year new hybrids are coming into bloom. Local growers also make crosses and bring their seeds for raising at the Gardens, while a few have now mastered the technique and raise them themselves.

The seedlings are first grown in conical flasks under sterile conditions. The medium used in Singapore is agar-agar with Vacin's solution and 2 per cent sugar, at a pH of about 5·2. Full details of the method are given by Holttum (1953b). In 1956 experiments were begun using coconut milk (the water inside the mature nut) in the medium and this is giving a considerable stimulus to the early growth of the seedlings. The mature orchids are grown in the open or with slight shade, either in pots or in beds, depending on the type, and details of the cultivation can be found in Holttum (1953b) and Henderson and Addison (1956).

Mention can only be made of one or two of the hybrids raised in Singapore. A fuller account of the principal hybrids, except for the very recent ones, with photographs of a spray and individual flower of each hybrid, has recently been published in Henderson's and Addison's *Malayan Orchid Hybrids* (1956). Vanda Tan Chay

Yan, which first flowered in 1952, was awarded a First Class Certificate of the Royal Horticultural Society at the Chelsea Flower Show in 1954 and is considered to be one of the best Vanda hybrids bred anywhere in the world. Arachnis Maggie Oei, now one of the principal cut flowers in Singapore, flowers continuously, whereas its larger parent *A. flosaeris* flowers but twice a year. Among the inter-generic hybrids bred in Singapore are *Aranda* (*Arachnis* × *Vanda*), *Aranthera* (*Arachnis* × *Renanthera*) *Renantanda* (*Renanthera* × *Vanda*), while our first tri-generic hybrid flowered in 1956 and has been named Ridleyara Fascad, in honour of H. N. Ridley. Mr. Ridley was informed of this shortly before his death.

There are a large number of enthusiastic orchid growers in Singapore and the Federation and there is a considerable demand for plants and seedlings grown in the Gardens. The sale of cut orchids, both local and for export, is rapidly increasing. An experienced cytogeneticist is expected to visit Singapore shortly to work on problems of orchid hybridization.

Sale of Plants

Although the sale of plants is not an essential function of a botanic gardens, it is desirable in those countries where there are few nurseries. The Singapore Botanic Gardens sells plants daily, but limits the sales to those plants which are not readily available in the local nurseries. The revenue from the sale of plants in 1956 was $27,245 (Straits), of which the major share came from the sale of 3,446 orchid plants and seedlings, while 26,092 other plants were also sold.

Advisory Work

The horticultural staff of the Singapore Botanic Gardens advise and assist various government departments in planning the lay-out and planting of roadsides, open spaces, school compounds, etc., and usually supply free material for this purpose. They also maintain close contact with the City Council Parks Department and many requests for advice are also received from private firms and individuals. Thus the Gardens play a large part in beautifying the city and island.

Men from the Rehabilitation Centre of the Labour Department are accepted for training as gardeners. The Director of the Singapore Botanic Gardens is the Imperial War Graves Commissioner's representative in Singapore and the staff of the Gardens take charge of the care and maintenance of the Kranji War Cemetery.

EDUCATIONAL WORK

General

The maintenance of a large, named and labelled collection of local and introduced plants attractively laid-out in the Botanic Gardens enables all visitors, who are interested, to increase their knowledge of plants. Parties of school children and students, both from Singapore and the Federation pay regular visits to the Gardens and occasionally parties are taken round by members of the staff. Special exhibits are arranged from time to time. One which proved popular with teachers and students was an exhibit of seven common plants which were changed weekly. The plants were labelled with their scientific, English and Malay names and family and brief notes were appended. Members of the staff are often requested to give lectures to local societies, a valuable method of educating the public in our work.

The staff of the Gardens co-operates fully with the staff of the University of Malaya's Department of Botany. The University is adjacent to the Gardens and so the latter are very handy for lecturers and students who wish to use them, while much material is provided for class work and research.

Singapore Gardening Society

The staff of the Singapore Botanic Gardens was largely responsible for the founding of the local Gardening Society, which at present has about 250 members. An active interest is taken in its work, as well as that of the Malayan Orchid Society. Some monthly meetings are held at the Gardens and emphasis is usually placed on practical demonstrations. A very successful annual flower show is held and the standard of blooms and plants exhibited is high. In these ways, the interest of local horticulturists is stimulated and the standard of gardening is raised.

PUBLICATIONS AND LIBRARY

It is very desirable that botanic gardens carrying out research should have their own journal for the publication of their results. Ridley founded the *Agricultural Bulletin of the Malay Peninsula* in 1891. The title was changed to the *Agricultural Bulletin of the Straits and Federated Malay States* in 1900 and it was then issued monthly. This journal was largely devoted to work on economic plants. Ridley published many taxonomic papers in the journal of the *Royal Asiatic Society, Straits Branch,* of which he was editor from 1889 to 1911, as well as being secretary of the Society. The title of the *Agricultural Bulletin* was changed in 1913 to the *Gardens' Bulletin, Straits Settlement* and in 1947 to the *Gardens'*

Bulletin, Singapore. This is published at irregular intervals and an attempt is now made to produce a volume per year. It is largely devoted to papers on local taxonomy. It is distributed to the major botanical institutions in the world and exchange arrangements now exist with 160 scientific bodies. It can also be purchased direct from the Botanic Gardens, Singapore. In exchange we receive valuable periodicals and reprints, which are so essential for our work, and which we would not be able to purchase from our slender library vote. The *Annual Report* is also printed and distributed.

In addition to these and other publications already referred to in this article, the Gardens staff prepares from time to time more popular works which are of general interest to the amateur. Such a work is Henderson's *Malayan Wild Flowers* (1949–54) published by the Malayan Nature Society. A series of small illustrated pamphlets, each containing drawings and brief descriptions of ten *Malayan Garden Plants* are also produced. Popular horticultural articles are submitted regularly to the *Malayan Agri-Horticultural Journal* and the *Malayan Orchid Journal.* Names and descriptions of our new orchid hybrids are published in the latter.

Adequate library facilities are essential for the research workers at botanic gardens. The taxonomist must consult original publications for the names and descriptions of the plants on which he is working, and for this the older, as well as modern literature is required. The Singapore Botanic Gardens are particularly fortunate in that they have one of the finest collections of old botanical books in South-East Asia, many of which are of considerable value and rarity. In all, the library contains some 8,000 bound volumes, as well as many periodicals.

Since 1890 there has always been an artist on the Gardens' staff, who prepares drawings and paintings for the specialist staff. The paintings done by James and Charles de Alwis between 1890 and 1908 are of outstanding beauty and accuracy and are among the treasured possessions of the Singapore Botanic Gardens. Over the years a large and valuable collection of plant drawings and paintings has been built up.

NATURE RESERVES

I have already shown how Cantley and Ridley were responsible for gazetting and maintaining the first forest reserves in the Straits Settlement. These were later taken over by the Forest Department. The Singapore forest reserves reverted to the control of the Botanic Gardens in 1937 and have since been maintained as nature reserves. Under the *Nature Reserves Ordinance* of 1951, some 8,000

acres in Singapore were "set aside for the purpose of the propagation, protection and preservation of the indigenous fauna and flora of the Colony", as well as "providing, under suitable conditions and control, facilities for the study of and research into matters relating into the fauna and flora and the physical conditions in which they live". The reserves are administered by a statutory board of management of six nominated trustees, with the Director of the Botanic Gardens as *ex-officio* chairman. The day-to-day administration is carried out by the staff of the Singapore Botanic Gardens.

Inevitably, with the spread of the rapidly increasing population, plants and animals, which were known to have occurred in Singapore, have disappeared completely. Every effort is being made to preserve the remnants which are left for present and future generations to study and enjoy. Only a comparatively small area of the nature reserves consists of primary vegetation. The most important is undoubtedly the Bukit Timah Reserve covering 163 acres on the highest hill on the island. It has been a botanical collecting ground for more than a century, and it is the type locality of many Malayan plants. It consists of primary tropical evergreen rain forest, with many trees 50–70 m. high, and for the greater part it has not been cut over nor damaged. There are also important areas of mangrove on the south coast preserved as a nature reserve.

Thus the Botanic Gardens have guarded jealously this heritage of the people, which might so easily have been lost for ever.

THE FUTURE

And what of the future? Singapore is shortly to receive independence. Already the Government has embarked upon a programme of rapid Malayanisation of its staff, although it is not likely that this will be fully achieved at the Gardens as rapidly as in some other departments. A local man has returned from training as a horticulturist at the Royal Botanic Gardens, Kew, while botanists and others are to be sent overseas for further training and on their return will take over from the expatriate officers. Much will depend on these new recruits to maintain the Gardens and collections and to carry on the tradition of research which has been built up during the past hundred years. It is hoped that the scheme recently devised to attract research workers from Britain and elsewhere to Singapore to carry out botanical research in their specialised fields will be continued and extended.

The Gardens are financed entirely by the Singapore Government and now come under the Ministry of the Chief Secretary.* In the

* In 1959 the Gardens came under the newly formed Ministry of National Development.
Editor.

1957 estimates a total of $546,780 (=£63,791) is voted to the Gardens and this includes the votes for the upkeep of Government House Domain and the Nature Reserves. If they are to survive, it will be necessary to convince the politicians and the general public that the Gardens are fulfilling a worthwhile rôle, not only as a public park, but also that the research carried out is of value to the economy and prestige of Singapore. As Commelijn said in 1701 (de Wit, 1949) "It is certain, however, that this Science, like all Sciences, flourishes sometimes more and sometimes less, all in accord with the inclination of Rulers and the Favour of Government."

A recent distinguished visitor wrote in my visitor's book "The Singapore Botanic Gardens are unique. Civilisation would be the poorer if they were not maintained." In discussing the history of botanic gardens in the tropics, I have shown how many of them were neglected or abandoned and failed in their primary function, which is the scientific study of plants. New botanic gardens are being founded at some of the new tropical universities and university colleges, but it will take them many, many years to build up the type of collection of living and herbarium specimens which is now available in Singapore. It is my fervent hope that the Singapore Botanic Gardens may be fully maintained for many long years to come and to continue as a leading centre of tropical botany and a worthy memorial to Ridley and those other members of the staff who have helped to raise them to their present position.

I have shown how in these uncertain and unsettled days there still exists much goodwill and active co-operation between botanic gardens, wherever they may be situated. As Baas Becking says in the Preface to *Flora Malesiana* "as long as sentiment, politics, greed and bigotry rule this world, a purely scientific endeavour may become a binding force between individual groups, and maybe, even between nations". If the aims and ideals which motivate the work of botanic gardens could be extended to certain other fields of human endeavour we could make this planet a better place on which to live.

ACKNOWLEDGEMENTS

In addition to the works quoted in the bibliography, reference has been made to all the published *Annual Reports* of the Botanic Gardens Department, Singapore from 1875 to the present day, as well as unpublished data in the files of the Department.

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Kew and Singapore

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"The gift of a useful plant seems to me more precious than the discovery of a gold-mine"—Bernardin de St. Pierre (*translated*)*

It is a pleasing thing that the Botanic Gardens at Singapore and the Royal Botanic Gardens at Kew should be celebrating in the same year, the one honouring 100 years of existence on the present site, the other commemorating the 200th anniversary of its founding. As we congratulate each other on the happy occasion and wish each other well for the future, it is also fitting that we recall the close bonds which have been woven between Kew and Singapore during their common life. In order to understand how these bonds came to be fashioned, it may be helpful to retrace some part of the history of the gardens at Kew.

The Royal Garden of Princess Augusta

Two hundred years ago Kew House, situated near the River Thames 7 or 8 miles above Westminster, was the residence of Augusta, Princess of Wales and daughter-in-law of King George II. Here this German princess had been brought by her husband, the Prince of Wales, soon after their marriage, and here she continued to live after his early death. In 1759 she decided on making improvements to the place. She engaged a prominent architect, Sir William Chambers, to re-design the grounds, and employed a skilled gardener, William Aiton, to make a garden of exotic plants or botanic garden. Chambers laid out the grounds in the fashionable mode of the day, building a handsome Orangery, a Great Stove (the largest heated greenhouse then in existence), a Pagoda, and various Temples; and some of his buildings are features of the gardens still. Aiton was no less industrious, and, in seeking plants for the botanic garden, Princess Augusta was greatly helped by the third Earl of Bute, whose influence was exerted to secure plants from many distant lands. Soon the garden became famed throughout Europe for the unrivalled variety of its plants.

* From the inscription on a memorial erected in 1860 in the Botanic Gardens of Pamplemousses, Mauritius.

New Functions for the Royal Gardens

It may be noted that, at the start, no more was desired of the garden than that it should provide pleasure and interest to its royal owner and her friends. In 1772 when Princess Augusta died, the garden was taken over by her eldest son who, by this time, had succeeded to the throne as King George III, and he increased the area of the property by addition of adjoining lands. For guidance in the care of the garden the King sought the advice of Sir Joseph Banks, a man of outstanding ability and scientific knowledge, who was to exercise a directing influence on its activities over a period of many years. His view was that the royal garden should become a place where the plant-resources of the world would be studied and made known, and where men might be trained who would go abroad to seek and collect new plants. These proposals, being approved by the King, set the Gardens on a course which has been followed to the present day. There have been times when the policy wavered, and indeed a bad period followed the death of Banks and George III when the closure of the Botanic Gardens was under consideration. But this, causing an outcry from a number of people who appreciated their value, led in 1838 to the appointment of a Commission to advise on the future of Kew. This Commission not only recommended the continuance of Kew as a State institution, but urged a more vigorous direction of its activities, in particular the study of plants and their uses, and the supplying of useful plants to territories overseas. To make effective these recommendations the first Director, William Hooker, was appointed in 1841.

In the years since then under successive directors, the study of the world's plants has been the main task of Kew. Here in the course of years, has been built up an unrivalled collection of plants, some in living state in the gardens and glasshouses, but many more in dried state in the Herbarium, providing a rich store of material for study of the identification and affinities of plants, their distribution over the world's surface, and the uses to which they can be put. Amongst this collection the flora of Singapore and of the neighbouring territories is well represented, thanks to the efforts of past collectors, and as a result Kew is able to be of assistance in the compiling of the great Flora Malesiana now being undertaken.

Kew Collectors

But it is in Kew's other functions, the sending out of men trained in the knowledge and care of plants, and the supplying of plants of economic use, that the strong links between Kew and Singapore have been forged. As early as 1772 men trained at Kew were being

sent abroad, the first, Francis Masson, being appointed by Banks to go to South Africa there to travel and collect seeds and plants for Kew. Masson proved a diligent collector sending back to England many plants hitherto unknown, of which some have since become garden-favourites. He subsequently made expeditions in Europe, the West Indies, and Canada, with such good results that Banks was encouraged to send out others.

Such a one was David Nelson who went as botanist in 1776 on the third voyage which Captain Cook made to the South Seas, and collected plants at many places where the ship called. Returning safely from this voyage, he was then appointed to Captain Bligh's ship H.M.S. *Bounty* sailing for Tahiti. At this place breadfruit plants were to be taken on board and Nelson's job was to see that they were properly stowed and tended during their voyage to the West Indies. The story of that ill-fated voyage and its mutiny is well known. Loyal to his captain, Nelson shared the privations of the open boat during the long journey to Timor, only to die a few days after reaching this haven, commended by Captain Bligh for his "manly fortitude in our late disastrous circumstances."

To retrieve this disaster a second voyage was made by Captain Bligh in 1791. On this occasion two Kew men accompanied the expedition, which was completely successful in conveying a large supply of breadfruit trees to the West Indies where they were established without difficulty. One of these men, Christopher Smith, deserves mention here as being probably the first man trained at Kew to give his service, if not to Singapore, at least to Malaya. In 1794 Smith was appointed botanist of the Honourable East India Company at Calcutta and, three years later, he was sent to the Molucca Islands to collect plants. These islands were then the centre of the spice trade which had been held as a strict monopoly first by the Portuguese and latterly by the Dutch. In 1797, through fortunes of war, Britain had access to the spice islands and Christopher Smith's commission was to obtain planting-material of valuable spice-trees for growing in the East India Company's territory. In this he was extremely successful, obtaining no less than 70,000 nutmeg trees and 55,000 clove trees of which the bulk went to Penang whence someone was able to write "we are now become masters of every kind of spice plant valuable or uncommon." Smith himself went to Penang to supervise their cultivation and died there in 1806. Doubtless from some of his trees were descended the nutmegs and cloves introduced in 1819 into the Gardens of the Agri-Horticultural Society in Singapore, which provided a useful source of revenue to the Society for many years.

About this time, botanic gardens were being opened up in many British colonial possessions. The first were in West Indies, at St. Vincent in 1764 and Jamaica a few years later. Then came gardens of the East India Company, at Calcutta in 1786 and Madras soon after, the spice garden at Penang about 1800, and the garden of Peradeniya, Ceylon in 1821. These places looked to Kew to provide men trained in horticulture, and Kew men soon filled a majority of posts in the colonial gardens and were responsible for starting horticultural work in many new territories. These men commonly remained in touch with Kew and there was often a frequent exchange of plants, Kew sending out plants of economic or ornamental value for the new gardens and receiving in return specimens of the indigenous vegetation.

Kew Men in Singapore

Singapore was added to the botanic gardens served by men of Kew in 1875, when the Director of Kew was asked to supply a practised botanist for the post of Superintendent. He chose Henry James Murton, a young man for the job, but a skilled and keen horticulturist. The Gardens at Singapore up to this time had served chiefly as a pleasure-park, and Murton deserves recognition for altering its character, for improving the collection of plants, seeing to their naming, and making trials of new economic plants. This work was continued from 1880 by another Kew man, Nathaniel Cantley, a great believer in system and orderliness, whose notable contribution to the Gardens was cut short by his early death. Both these men had the assistance of a third trained at Kew, Walter Fox, whose service in Singapore and Penang extended over 31 years. These three did much to set the Botanic Gardens on the right lines and prepare for the progressive development which followed under H. N. Ridley and his successors. In more recent times men trained at Kew have continued to be appointed to Singapore and, amongst them, we would pay tribute to a splendid horticulturist J. C. Nauen, whose service to his fellows and gallant death as a prisoner-of-war are remembered at Kew, as doubtless at Singapore.

It must not be suggested, however, that movement between Kew and Singapore has been all one way, for it was to the vicinity of Kew that Ridley came on retiring from Service in Singapore and, so long as he remained in active health, he visited the Gardens at Kew almost daily. Another former Director from Singapore, R. E. Holttum, is also a neighbour at Kew, and both I. H. Burkill and E. J. H. Corner are sufficiently near to be occasional and welcome visitors. It is a happy occurrence that in this year of celebration the Kew Guild, the association of present and past members of the

Kew Staff should have as its President F. Flippance, a Kew man whose long experience in the East has included service in the Singapore Botanic Gardens. Moreover at Kew we have been glad to welcome as student-gardeners young men from the Gardens at Singapore who, after a period of training at Kew, return east with a widened knowledge of plants and of horticultural skill. These too, it may be hoped, will help to strengthen the bonds between the two Gardens.

New Plants for the East

For these are the strong links between Kew and Singapore, the men such as have been mentioned whose skill and loyal service have been shared by both places. Nor must we forget the plants distributed from Kew which have formed so useful a link with other gardens.

Reference has been made to co-operation between the Honourable East India Company and the Royal Botanic Gardens, and this had as one of its most productive results the introduction of quinine into the Far East. A century ago, while the effectiveness of quinine against malaria was well known, the drug itself was scarce and not generally available, since the only source was the wild growth of Cinchona trees in the Andes. An expedition to South America in 1860 was successful in obtaining seed of several species, and the seedlings, raised at Kew, were sent to India, Ceylon, and other places. In India particularly the plants were readily established and plantations were made on a large scale with the result that quinine was soon obtainable throughout the East at low cost. The influence this introduction had on general health and well-being can hardly be estimated.

So encouraging was the outcome of this venture that it was followed by a second, an expedition to Brazil to collect seed of the Para rubber-tree. A supply of seed was sent to Kew in 1876 and gave rise to seedlings which, as soon as they were large enough, were distributed to countries where it was thought they might suitably be grown. A case of these plants sent to Singapore in 1877 came into the hands of H. J. Murton, and 12 plants survived to be planted in the Gardens at Singapore and 9 at Kuala Kangsar in Perak. From these plants, and others which came subsequently from Ceylon, was built up the great rubber industry of Malaya, which brought a new commodity into every civilised home and made possible a new era in road-transport.

It may seem idle to conjecture what the history of Singapore would have been if Hevea had not arrived when it did, if the threatened closure of Kew in 1838 had in fact taken place, if the

Gardens at Singapore had not been in running order with a Murton and a Ridley to take charge. Such thoughts are not altogether vain if they bring home to us what great service these botanic gardens have rendered through the exchange and development of useful plants. Nor must this be regarded as their only, or even their chief, function, which, as has been shown, is the study of plants and plant-resources in its widest sense.

Botanic gardens have not been without their critics, who, at different times and places, have pointed out how much money is spent and how little comes back as revenue, urging that they be closed or their activities trimmed in the interest of economy. Looking back 100 years, and 200 years, we can clearly see how time has fully justified the men of vision, men like Banks, the Hookers, and Ridley, whose faith in botanic gardens led them, not to close them down, but to develop and shape them to serve the community to best effect. Having viewed the splendid record of the past, we can look to the future of these Gardens with confidence, believing that the skill and devoted service, which have already achieved so much, may have no less a contribution to make in years to come.

Singapore and Flora Malesiana

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In my tribute to the healthy centenarian, the Singapore Botanic Gardens, I feel that the intimate relation which has grown in the past years between the Singapore Botanic Gardens and the *Flora Malesiana* requires an introduction and an explanation. Many of the Singapore citizens will know this work only by name but not by personal experience.

Let me first explain this *Flora Malesiana*. It intends to be a modern critical inventory of the native, introduced, and major cultivated plants of the entire Malaysian region. This is the whole archipelago between the Asiatic and Australian continents including also Singapore and the Malay Peninsula up to about the isthmus of Kra where the flora rather abruptly changes into that of continental South-East Asia. It wants to give critical data on the ecology and distribution of all the plants, of the altitude at which they occur, the soils which they can stand or prefer, the climates which they tolerate, their mode and period of flowering and fruiting, the manner in which they are pollinated, the mode of dispersal and germination of their seeds, etc.

The knowledge to be accumulated must be carefully collected by qualified, scientific botanical specialists and we are happy to put on record that many prominent persons all over the world have been persuaded to add to the effort. Malaysia is botanically one of the richest countries of the tropics, it can boast of probably not far from 25,000 different species of flowering plants in all, from the tiny herbaceous up to the colossal tualang and the majestic jelutong, unique creations of tropical nature beside which man feels his smallness.

The exact knowledge of this vegetable wealth has grown slowly and gradually, in former times largely from curiosity of disinterested scientists, local and overseas, but it appears more and more in modern time that this knowledge is intimately connected with far-going aspects of human welfare, land-use, economy, and industry. The fast-growing world population, with its increasing needs and its stupendously developing techniques, is steadily asking more information about the three kingdoms of nature, the earth, the animals, and the plants. Among these kingdoms the

plants play an enormous role by their bulk and by the easy way in which man can manage them. But before man can use them efficiently he must know their identity, their name. The critical name of a plant species is the alpha of botanical knowledge, it is the key to our knowledge of it. And that is what we intend to accomplish with the *Flora Malesiana*. Following this trend of thought it will also be clear that, though elaborated by disinterested research, the *Flora Malesiana* is automatically becoming a most useful tool for humanity in the East.

How is it then, the readers will ask: have we not already a Flora of Malaya? This is admittedly true, there are even three with a start of a fourth. The flora of Malaya was in the past century incorporated in the *Flora of British India.* Shortly afterwards it was the subject of the excellent work by King & Gamble, *Materials towards a Flora of the Malay Peninsula,* and finally there is the more recent *Flora of the Malay Peninsula* by Ridley.

The first two treatments are good but more than half a century old and naturally very incomplete. The third one unfortunately does not come up to the required standard of accuracy. All of them suffer from two inadequacies, viz the lack of correlation with plants described from other parts of Malaysia and the lack of general data, on uses, distribution, and ecology of the species. The second desideratum was to be filled in the *Revised* (fourth) *Flora of Malaya* initiated a few years ago of which two volumes were issued, viz on the orchids and ferns, by Professor R. E. Holttum. Admirable as these volumes are, there is still the lack of correlation notwithstanding their author's speciality on these two groups.

A large plant geographical study has revealed that Malaya, Sumatra, Borneo, the Philippines, Java, the Moluccas, and New Guinea form for plants one unbreakable whole. Plants do not keep to political boundaries, they have a distribution of their own and attained their area through the geological ages of the past. This means that for an adequate knowledge of their identity they should be pursued throughout that area.

We should strive then first towards a general Flora of the entire Malaysian province, as Nature made it, before giving an account of a politically defined part of it, a so-called local Flora.

A few days ago I was struck again by the truth of this basic principle, in trying to arrange the species of a rather important timber genus *Campnosperma,* tĕrĕntang or sĕrĕntang as it is known by its vernacular name; it is common in the lowland and swamp forests of Malaya. Mr. Corner, who in 1939 made a study of it on the basis of material from Malaya only, concluded that there was an undescribed new species, tĕrĕntang jantan of Johore, which

he called *Campnosperma minor* and which would be unique to Malaya. But revising the genus over the whole of Malaysia a few weeks ago, it appeared to two of us that this same new species had already been described from the swamp forest of Borneo, under the name *Campnosperma squamata* by Ridley in 1933, but occurred also in the Moluccas and New Guinea and from there had been described still earlier as *Campnosperma montana* by Lauterbach in 1920. The latter is obviously the oldest and correct name for it. Once that is known we can properly proceed to judge its ecology and uses over its entire range and we know where we are.

This example is no exception, unfortunately it is the rule as soon as groups are revised regionally. The background of this rule is the fact that in the past the study of the flora of the Malaysian region has been approached by local work, in Malaya, in Java and other parts of Indonesia, in the Philippines, in West New Guinea, and in Papua, instead of by regional attempts covering the entire archipelago. This serious lack of correlation we try to remedy by the Flora Malesiana attempt, from which all separate states and territories will have the same benefit. In this whole, Malaya, with its very rich flora, forms an essential integral part.

The senior leaders of Malayan botany, who were or are directors or staff members of the Singapore Botanic Gardens, have in the past decade realized the scientific necessity to give priority to a regional flora over a local flora, large as it may be, and Flora Malesiana is happy to have their authoritive collaboration. Mr. Burkill Sr., the author of the standard work on the *Economic Products of the Malay Peninsula,* revised the yam family (Dioscoreaceae), Mr. Corner is doing the colossal job of tackling the fig family (Moraceae), Mr. Sinclair revised the nutmeg family (Myristicaceae) and intends later to work on the kenanga family (Annonaceae). Mr. Furtado has also, in his studies on aroids and palms, felt the need to step far beyond the borders of Malaya. Last not least, Prof. Holttum is organising the Pteridophytes, a lofty attempt; it will take him at least ten years to come to achieve this, his final magnum opus.

One might query: but what is the use for Malaya to know all about the floras of the other islands, even as far as Papua? This question has already partly been answered by the example of *Campnosperma* given above. It is curious and possibly of interest to Malayan readers to know that the closest relative of the genus *Hevea,* to which the pararubber tree belongs, is a tree native in Papua, *Annesijoa novoguineensis.* In wider scope this question is part of the general issue: what is the potential use of plants?

Frankly, no botanist is capable to say which plant can be of what special service to man and which not. It is certainly not determined by size: most humble annual plants like flax have shown their importance whilst woody giants are sometimes of hardly more value than as firewood. Use depends on the needs of man and that varies with place and time. The tuba plant (*Derris*) was until the twenties only locally used as a fish-poison until it appeared that this fish-poison contained a powerful insecticide harmless to man. Then it became at once an industrial plant from which money could be made. Nowadays interest in the plant has waned as during the war other, artificial insecticides have superseded it. When in the thirties it appeared necessary to have pararubber latex shipped in bulk, without coagulating the milk, the tuber of a fetid aroid containing a special kind of starch which could do that trick, but to which no use had ever been ascribed, came into great demand.

Some other Malaysian plants have never reached the industrial phase, possibly because they have never been given a trial, such as the bark-cloth yielding figs and champedaks. Nothing is yet known about possible industrial qualities of these fibres.

Timber and wood-pulp are naturally of basic value, but it is not certain that Malayan trees used for that purpose are the most economical that grow on Malayan soils; possibly the Papuan eucalypt (*Eucalyptus deglupta*), a rain-forest species, is superior.

Useful plants for specialized purposes, specially for medicinal use, are still hidden among the native flora, sometimes even in Malaya itself and the vivid interest in *Strophanthus, Rauwolfia, Kopsia,* and other alkaloid-containing plants are contemporary examples. But the phytochemist cannot work with anonymous material: he must know the exact name of the plant which he is analyzing, under what conditions it can grow, and where it occurs. That information he will ultimately find compiled in the *Flora Malesiana.*

This seems enough to demonstrate to non-botanists the value of that scientific basis for applied work in botany: *Flora Malesiana.*

I have alluded to above to the heart-warming fact that all former and recent systematists of the Singapore Botanic Gardens participate in this great work and that through the farsighted policy of its director, Mr. H. M. Burkill, it figures on the official programme of the Gardens. It is evident that for its completion we will need at least another twenty-five or even more years, depending on money and manpower of specialists. Though in the past ten years three thick volumes have appeared the major part of the work still remains to be done and our sincere hope is that not only retired

officers of the Singapore Botanic Gardens will collaborate in an honorary function, but that the number of active staff members will be increased for this purpose and brought at least to pre-war strength.

The eastern tropics have always been much better provided with botanic gardens than Africa and South America. Unfortunately the Calcutta Gardens, the oldest, have since long lost their standing as a scientific botanical research centre and the same can be said of Peradeniya. In the past few years the Bogor Botanic Gardens have almost been deprived of scientific personnel and no qualified systematist is any longer on the staff of the Herbarium, to the great regret of its director. The Singapore Gardens suffer in less degree from the same evil of having several vacant posts. I trust that this situation will be improved in the near future, as whatever high qualification can be given to a Garden in the way of collections of living plants, herbarium, buildings, space, and library, its scientific activity which is decisive for its importance depends on the quality and size of the scientific staff; first brains, then books, then bricks.

It is this scientific activity which is of the highest importance in the world of today, and upon which progress depends more than ever.

With the occasion of a centenary one is apt to look backward; there we see a dignified growth of an outstanding botanical centre in the East; gradually as a matter of fact, but all good things grow slowly.

But we have also to look forward, in the future. There we see a vista of intensified and extended scientific research to be achieved for future generations, for their education and welfare, for adequate use of the land, appropriate utilization of plants and their products, made possible by critical knowledge and study of them.

The *Flora Malesiana* is a useful tool towards that aim intended for the future generations of the eastern peoples. The sooner it will be completed and be available the more profit it will yield. I trust that the Administration, convinced of this profit, will find ways and means to increase Singapore's contributions towards this goal and be proud of it.

A tale of two cities: Singapore and Leiden

By H. J. LAM

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I FEEL BOTH pleased and honoured to find myself amongst those who were invited to contribute towards the Centenary number of this Bulletin, because "Singapore" (meaning the Botanic Garden) is one of the important centres of botanical research in insular Asia. There is, and was, a marked parallel relationship in that Singapore was, in a way, an affiliation of Kew and Bogor of Leiden. In addition, there were close bonds between Singapore and Bogor in the Far East and between Kew and Leiden in Europe.

When speaking of these four places it must be stated that the relationships between them were, in more recent times, principally maintained by the respective herbaria, all of which are younger than the botanical gardens they belong to or are connected with. And since the present commemoration actually deals with the garden it may be stated first that in this respect Leiden is the senior institution, since its botanical garden was created shortly after the establishment of the University (1575), viz. in 1587. Followed Kew in 1759 (as a Royal Garden; 1841 as National Gardens), Bogor (Buitenzorg) in 1817, and Singapore in 1859.

From times immemorial botanical gardens were institutions with a prevailingly practical aim, viz. the study of medicinal plants. As far as means of conveyance permitted there was an ever increasing exchange of material and many gardens organised collecting trips in order to augment their assortment. In this way a great number of useful plants, medicinal and otherwise, became known or better known and in the nineteenth century quite a number of large tropical crops owed their origin and extension to being first studied in botanic gardens, e.g. pararubber (*Hevea*), quinquina (*Cinchona*), coffee (*Coffea*), tea (*Thea*) and numerous others.

In later years when experimental gardens and stations were created, the original aims of botanical gardens gradually shifted to these specialised institutions, and while the study of the flora was transmitted to the herbaria which naturally grew out of collections of dried specimens of the local flora in and around the gardens proper, the latter more and more served as open air (and hothouse) museums of the wealth of plant forms with both decorative and

RIJKSHERBARIUM
LEIDEN

General herbarium to left of entrance and working rooms to right

The Dutch Herbarium and Cryptogamic Herbarium
An annexe to the General Herbarium

scientific purposes; decorative so as to indulge in the growing demand of recreation by town-dwelling people and their natural craving to admire the wonders of plant life; scientific so as to meet the increasing necessity of developing sciences such as plant physiology, biochemistry, experimental taxonomy, and the like.

As a matter of course the aims and purposes of the temperate gardens and tropical ones soon diverged. The first-named ones, *in casu* Kew and Leiden, grew next to indigens such plants from as many different vegetational and floristic areas as they could lay hands on, and various artificial habitats were created for these according to their ecological preferences and exigencies. The tropical gardens, i.e. Singapore and Bogor, naturally showed first of all a display of the surrounding vegetational riches and furthermore strove for the cultivation of tropical plants other than their own.

In the meantime, as we said, herbaria came into operation. Old collections of dry plant specimens, some of these as old or even older than the garden whose property they were or became, were assembled and arranged. Much new material was added, more and more intentionally and methodically, as collectors or expeditions were sent out, and gradually a worldwide system of exchange of duplicates as well as of borrowing and lending on behalf of monographic work was brought about.

Whereas thus a wealth of information was obtained, catalogued, and systematically published, it soon appeared that the floras of all countries and particularly those of tropical areas whose study had been tackled at a much later date than that of temperate ones, was unbelievably richer in every respect than had been long anticipated. It is now recognized that our knowledge of the more intimate details of the vegetable kingdom is still in its infancy. Again the temperate situation differs from the tropical one. In temperate countries the higher plants are generally fairly well known specifically although much work has still to be done on variability, specific and infra-specific limits, and nomenclature. The study of lower plants (Thallophyta), however, which started little over one hundred years ago when the microscope got its first modern construction, is now well under way and shows an unexpected and bewildering wealth of forms and products, particularly in the fungi.

The tropical countries are, also in this respect, still very much "underdeveloped". The causes of this are not only that western science started its investigation there at a relatively late date, but that their flora appeared to be infinitely more diversified than that of e.g. N.W. Europe (which, among its temperate sisters, is particularly poor as a consequence of the comparatively recent glacial periods). It has taken some considerable time to arrive at the

recognition that on studying life phenomena, biologists should have started in the tropics with their optimal environmental conditions rather than in any temperate climate. Unfortunately at the time when western science consciously penetrated in those areas, the basis of many sciences and their terminology had already been laid and this has been the cause of the fact that all too long tropical life has been considered a special case of temperate phenomena, instead of the reverse.

Today, our knowledge of tropical plants is still scanty. That of higher plants, though tolerably good in and near cultural centres such as in S. Malaya, W. Java, and S. Luzon, is very much inadequate regarding such large areas as central Borneo, New Guinea and a number of remote smaller islands. Practically every explorer in those parts collects numerous unknown species and is even likely to discover new genera.

As to the lower plants such as fungi and algae (including kelps), our knowledge is entirely haphazard and we still have to find our way in this enormous *terra incognita*. Everybody knows how much the life of tropical peoples depends on their surrounding plant world. But even though their very intimate daily contact with that plant world is the outcome of an association of tens of thousands of years, it should not be believed that nothing in it can be improved and that nothing is to be added. On the contrary. Already science has revealed many useful particulars of plants so far unrecognized. A striking example is that of the unpretentious shrub *Rauwolfia,* practically unknown only a few years ago, now of extensive fame as a producer of a very effective remedy against high blood pressure. Numerous other plants containing substances which are surmised to be of potential value to men are still unknown phytochemically, numerous others doubtless are still to be discovered and native plantlore may serve as a guide where to look for them.

But also among the lower plants untold riches and possibilities are undoubtedly stored away. Already certain fungi play a very important part in native food stuffs but our knowledge of their processes is extremely scanty and many of them are waiting to be accurately investigated, cultivated, hybridized and segregated in order to give them their optimal efficiency.

For all this the botanic garden, its affiliations and its incorporated institutes, including the herbaria, are there to serve as an indispensable tool and medium to be used for the benefit of the people.

At present, the relationships between the four botanic gardens is rather more platonic than practical, though I do not underrate the value of occasional exchanges. But the emphasis of the cooperation clearly lies on the work of the herbaria. Of these again

Leiden is leading as far as the date of origin is concerned. The Rijksherbarium as it is called—or national herbarium—was founded in 1829 in Brussels and it was moved to Leiden in 1830. Kew, now by far the largest herbarium in the world, followed in 1841, Bogor in 1844 (the date of 1817 mentioned in Index Herbariorum is that of the garden, not of the herbarium), and Singapore in 1875. Naturally Kew got the best opportunity for a rapid extension of its collections from all over the British Empire. The Dutch national herbarium in its modern form was based on the extensive collection made by BLUME and some others in western Java after the Dutch had retaken supremacy from the British interregnum in Napoleonic times. To these some older garden collections were added, some even older than the university.

During the whole of the nineteenth century numerous collections were added from the Malay Archipelago as well as from many other parts of the world, notably the West Indies. Around the secular turn the study of the West Indian flora was taken over by the Utrecht School, founded by PULLE, but the Rijksherbarium received more and more acquisitions from the Malaysian area, as a consequence of a very close co-operation between Buitenzorg (now Bogor) and Leiden. Bogor has grown to be a very important tropical herbarium and it must be stated with great satisfaction that in spite of unfortunate political misunderstandings the mutual institutional and personal relations with Leiden have remained excellent, thanks to our colleagues KUSNOTO and DILMY.

After the second world war the Rijksherbarium has again increased rapidly. Next to Bogor it is the recognized world centre for the study of the Malaysian flora, particularly important because of the great many types, especially older ones. In addition, after Berlin had lost its leading position regarding the flora of New Guinea, Leiden has taken over here, and a new scientific co-operation has arisen between Lae, Canberra and Leiden. The total average yearly acquisitions now amount to some 40,000 specimens.

The activity of the Leiden herbarium has greatly increased as the staff grew to the present number of 17 full-time botanists and 6 honorary fellows. Of the former 8 devote their time to the study of the Malaysian flora and 4 of them, now still in the service of the Flora Malesiana Foundation of which VAN STEENIS gives an account elsewhere in this Bulletin, will possibly be taken over gradually by the Rijksherbarium now that the Bogor staff, temporarily I trust, has been curtailed in a most lamentable way.

Naturally the co-operation between the two tropical and the two temperate institutions has been mutual. Either party would be greatly hampered in its activities without the assistance of the other.

The older collections and types are preserved and best represented in Europe, more recent ones in the tropics, though duplicates have been liberally ceded. The indispensable literature is generally more copiously available in Europe (though Bogor can boast of a remarkably rich library). Living specimens, on the other hand, can only be studied in the tropics and the same is true for all characters which lose their value on the plants being dried.

As has been stated above Singapore has ever maintained a similar bond with Kew as that which exists between Bogor and Leiden. Yet the direct relationship between Singapore and Leiden has by no means been negligible. The exchange of duplicates from 1948 (inclusive) to May 1959 amounts to 2,600 from Leiden and 6,700 from Singapore, material on loan in the same period to 1,300 from Leiden and 21,000 from Singapore. These figures are significant: on the one hand they show the main source of the material, and on the other the place where it is mainly investigated.

Thus, the Singapore Gardens and their valuable herbarium represent a rich source of important information and the Rijksherbarium is proud to be allowed to co-operate with its staff. We on our side participate in this work out of pure scientific interest in the overwhelmingly rich tropical flora and vegetation with its countless and inexhaustible scientific problems. Our tropical friends on the other end of the line, who daily enjoy the inspiring neighbourship of their flora, know that ultimately they work to the profit of their country. To both parties co-operation is a living necessity, for better and for worse.

On offering the Singapore Gardens our hearty congratulations on their first centenary, I venture to express the hope that our co-operation will hold, nay, be intensified for many years to come, to the benefit of science and the welfare and happiness of the human race.

A Note on the Gardens' Jungle

By I. H. Burkill
Director, Botanic Gardens, 1912–25

This is an incident of 35 years ago at which time search was being made for a site that could be used for the proposed University buildings in Singapore, and the Economic Garden has been mentioned. On one afternoon I met in the Economic Garden a friend from Johore who was taking the opportunity of a visit to Singapore to form an independent opinion. So we walked round the Economic Garden together and discussed the subject. It was not difficult to agree that the site, having become surrounded by houses was now a town site with a value greater than that to which it was put as a nursery. But when we returned to the Botanic Garden he dropped a remark which was astounding,—pointing to the Gardens' jungle he recommended that it should be used for houses. It was useless, I found, to point to the beauty of the trees: he could not see it. He grudgingly consented that these as trees added certain species to the display in the Gardens; but could they not be seen in plenty in the forests of the Peninsula? It was quite beyond him to think of one tree helping another to live; are they not competitors; he claimed. At this I gave up my pleading.

Those beautiful trees, mainly of three species of Shorea, when they were but seedlings grew in the shade of others and as they surmounted the ground-vegetation of their habitat gradually fitted themselves for drier air and stronger light. Now they are the means of preventing the death of various tender companions and more than that they are the front line in the preservation of the humidity not only of the soil under them, but of the air necessary for the healthy growth of the palms in the Palm Valley.

The Dell at the head of the Gardens' Lake furnishes another illustration of interaction between different items of maintenance within the Gardens' boundaries; or the humidity maintained by the Lake makes the display of the Dell possible.

Any interference with either source of humidity could do more damage than the man in the street can realize.

The Singapore Botanic Gardens and Forestry in Malaya

By J. WYATT-SMITH
Forest Department, Federation of Malaya

ALTHOUGH Singapore and the Federation of Malaya are today two separate countries, and the Singapore Botanic Gardens and the Malayan Forest Department two entirely separate organisations, it is, perhaps, not realised except by a few that the first forest department in Malaya was that of the Straits Settlements and that it was formed in 1883 under Cantley, the then Superintendent of the Botanic Gardens, Singapore. It remained under the Botanic Gardens until 1901 when the administration of forests was handed over to the Land office. It may also not be realised by many that it is mainly due to Ridley who became Director of the Botanic Gardens and Forests in 1888 that Malaya owes the survival of many of the existing forests in Malacca, Penang, and the Dindings.

During this period the forests of Negri Sembilan, Pahang, Perak, and Selangor, the former Federated Malay States, were under the charge of the Land Officers, but in 1895 a full-time Forest Officer was appointed in Perak. Forestry in Malaya owes another debt to the Singapore Botanic Gardens when a year later Ridley, in a report on the forests of Selangor, recommended the establishment of a properly organised forest department under a forestry trained officer for the four Federated Malay States. This was unfortunately not acted on, though special officers were appointed for Selangor and Negri Sembilan. Four years later in 1900 Hill of the Indian Forest Service was commissioned to advise on the forest administration of the Straits Settlements and Federated Malay States, and a year later Burn-Murdoch was transferred from Burma to form a department.

One of the early duties of any forest department is to obtain a census of the forest resources available both in existing forest reserves and on State Land, a census not only of the species that occur, but of their distribution, frequency, size class distribution, and subsequently of their ecological characteristics. Such a census or stock taking is, however, of very reduced value if the identity of the material is not known and if it is uncertain whether any material collected is composed of many or a single species. Plant collecting and the setting up of a small forest herbarium are therefore logical developments, and in 1918 F. W. Foxworthy, a botanist

and wood technologist of international repute who had spent many years' service in the Philippines, was engaged as Forest Research Officer. Determinations were naturally, however, still largely sought from botanists working in the established herbaria of the world that were concerned with plants of this region, and particularly those at Kew and Singapore. The establishment of the Forest Research Institute at Kepong in 1929 with increased research staff saw the growth of the departmental herbarium with particular attention being paid botanically to this region's important timber family, the *Dipterocarpaceae*. The Institute, however, was still dependent on other herbaria and particularly Singapore for assistance with determinations; and, in the case of Singapore, which is near at hand, for reference to their excellent library. It is frequently not realised by the layman how important these old works are to taxonomists and also how important it is to have easy access to type sheets or authentic material. Adequate collections and distribution of duplicate material to many of the well-known general herbaria in the world and to those specialising on the flora of the area are undoubtedly the means of overcoming this, as is readily done today. But there is no such solution for old plant collections nor for many of the old books or journals published which, even if they do appear periodically on the market, are usually so expensive that they are completely beyond the means of any new herbarium. It might almost be stated that existing and long established herbaria such as the Botanic Gardens Singapore, in view of their old collections and their libraries, have an obligation to the scientific world and particularly to their region to maintain their activities, since no newly formed institution can ever hope to obtain the same essential foundations. And this obligation, we are pleased to say, is fully accepted and met by the Singapore Gardens.

The herbarium at the Forest Research Institute has naturally specialised in woody species and is really no more than a reference herbarium for the Forest Department. Up to World War II interest was focussed particularly on the dipterocarps, and a collection has been built up, mainly through the efforts of Symington, which apart from early material and types is possibly the best in the region. Since World War II the emphasis has been on the other important timber producing families and on many of the smaller woody plants, the latter being required in connection with ecological studies of rain forest. Many of the final determinations and all the preliminary determinations are being done at the Institute, but continued reference is still made to the herbarium and assistance required from the qualified staff of the Singapore Botanic Gardens. It is certainly not

envisaged that the Forest Research Institute with its present botanical facilities can ever dispense with the resources of the Botanic Gardens, Singapore, and it is earnestly hoped that it will be found possible to maintain the herbarium, library, and staff of the Gardens at the highest level for the next hundred years as has been so well done during the past century.

Apart from the early guidance in direct administration of the forests of the former Straits Settlements, the subsequent assistance with determinations and permission to use the library and herbarium, the Forest Department has also benefitted in the extreme interest shown by these early and subsequent botanists in the local flora and the large number of publications concerning trees and forest produce that they have published. Works that immediately spring to mind and with which all Malayan forest officers are acquainted are Ridley's *Flora of the Malay Peninsula* which was based on King and Gamble's *Materials for a Flora of the Malay Peninsula;* Burkill's *Dictionary of the Economic Products of the Malay Peninsula;* Corner's *Wayside Trees of Malaya;* Holttum's works on orchids and on ferns which form Volumes I and II of the new *Flora of Malaya;* many articles in the *Gardens' Bulletin* including Holttum's works on bamboos and gingers, Furtado's work on the rattans and canes, Sinclair's on the two tree families *Annonaceae* and *Myristicaceae,* Henderson's on the important timber genera *Calophyllum* and *Eugenia;* and Henderson's *Malayan Wild Flowers* published by the Malayan Nature Society. In addition numerous vegetational papers by members of the Botanic Gardens' staff have appeared in such Journals as that of the Royal Asiatic Society and the Federated Malay States Museum, papers which are of great interest and value to forest officers. We may mention here that the traffic has not been all one way, for Departmental botanists, particularly Symington in connection with dipterocarps, have contributed to the Bulletin of the Singapore Gardens. And some of the series of *Malayan Forest Records* are valuable items in the botanical literature of Malaya.

The Singapore Botanic Gardens and Rubber in Malaya

By P. R. WYCHERLEY

Botanical Division
Rubber Research Institute of Malaya

NATURAL RUBBER PRODUCTION in Malaya and other tropical Asian countries depends upon the cultivation of *Hevea brasiliensis*. This tree was introduced into the East and its exploitation developed through the agency of various botanical institutions and, as will be shown below, the part played by staff of the Singapore Botanic Gardens has proved exceptionally important.

The changing fortunes of the rubber producing industry have reflected the trends of world economic history during the first half of the twentieth century. Although during times of trade depression the plantation industry has done little more than provide a survival existence for its many employees, on balance natural rubber production has made one of the greatest contributions to prosperity in Malaya. This has been achieved in the first place by the attraction of capital and latterly because the industry has become the largest single source of employment and revenue in the Federation of Malaya. At present rubber plantation employees number over a quarter of million and it is estimated that nearly 400,000 smallholders are supported wholly or partly by rubber cultivation. Direct taxation of rubber exports has provided about 15 per cent of the total Federal revenue during the last five years. This figure was swelled by taxes on company profits and by other less direct means.

This enterprise, which has given a livelihood to a large section of the population representative of all races in Malaya and provided wealth for the country's development, owes its origin mainly to the Singapore Botanic Gardens.

The Introduction of Hevea to the East and Establishment in Malaya

The distribution of potential crop plants to enhance the utilisation of natural resources was a conspicuous feature of the work of the Royal Botanic Gardens, Kew, and its daughter institutes while Joseph Hooker was Director. He was knighted in 1877 and in 1897 honoured for his editorship of the Flora of British India.

Mr. James Collins had reviewed the rubber producing species of plants at the request of Sir Clements Markham of the India Office, the latter recommended the collection of *Hevea* from Brazil and its despatch to oriental territories, and Hooker implemented this recommendation.

Although several attempts were made under Hooker's guidance or by the India Office, only one—the famous Wickham collection—succeeded. The others failed either because the seed did not germinate or owing to the selection of unfavourable reception sites such as Calcutta and Sikkim where the plants died.

The success of the Wickham collection owed much to the expeditious handling of the material. Joseph Hooker commissioned Mr. H. A. Wickham (later Sir Henry) to collect seed, which he did in the area between the Tapajos and Madeira rivers of the Central Amazon basin. Wickham chartered a cargoless ship to rush his 70,000 seeds to England. At the expense of digression from the main theme the charge against Wickham of smuggling should be refuted here. Although he may have disbursed hospitality to speed official clearance of his perishable cargo, there is no evidence that he resorted to corrupt evasion of the law; in fact the shipment of seeds of *Hevea* from Brazil was not prohibited at that time and an official statement—*Borracha no Brasil,* Rio de Janeiro, 1913—reported that Wickham's and other exports were made with the goodwill and co-operation of the Brazilian government.

The seed reached Kew on 14th June, 1876 and Hooker ensured careful treatment; he obtained about 4 per cent germination, which was good considering the long journey and that it was unknown how the seed should be packed or treated. The bulk of the seedlings were despatched in Wardian cases (miniature greenhouses) to Ceylon, where extensive nurseries had been prepared at Henaratgoda on the orders of the India Office. Further shipments from Kew in 1876 were 18 plants to Java and 50 to Singapore, but the latter arrived at the Gardens in poor condition and the five survivors appear to have died subsequently. The following year 22 plants were sent from Kew to Singapore and successfully established by Mr. J. H. Murton, Superintendent of the Gardens.

The distribution of these plants is not fully known. Murton went plant collecting in Perak during October to December 1877, when he planted nine *Hevea* seedlings at Kuala Kangsar behind the old Residency on the bank of the Perak River. The Resident was Mr. (later Sir) Hugh Low, who, like Sir Stamford Raffles, was an active naturalist and very interested in economic botany. Murton is reported to have planted one of the 'Wickham' seedlings with other rubber bearing plants at Durian Sabatang. This may have been the

Durian Sabatang near Telok Anson, but his intinerary did not include Lower Perak unless he made an unrecorded call during the sea voyages between Singapore and Penang. He passed near the Durian Sabatang about twenty miles south of Matang and Taiping. Both these places together with Telok Anson have been quoted as sites for one or more of the first introductions, probably all referring to the single plant, which appears to have been soon lost for no traces could be found by Low in 1878. At least nine seedlings were retained at Singapore. The important point is that Murton established *Hevea brasiliensis* in two centres where the trees could be tended and observed, namely, at the Singapore Botanic Gardens and under Low's good care at Kuala Kangsar.

The plants at Singapore were multiplied to a limited extent by cuttings. However, Murton found, as has been confirmed repeatedly since, that only cuttings from young seedlings rooted easily. Thus there was a limit to the amount of material which could be propagated by this means. Nevertheless it is interesting and to Murton's credit that he was alive to the potentialities of the method and investigated its possibilities. The most suitable site was sought by Murton, his successor, Mr. N. Cantley and Mr. W. Fox, and, after two transplantings, the *Hevea* collection found a home in the newly acquired Economic Garden in 1879. Unfortunately the Government provided no funds for the upkeep of the Economic Garden and scrub invaded; thus by 1885 the trees were in a poor state of upkeep. The numbers were reinforced from 1884 onwards with the progeny of the originals and new imports from Ceylon. This was most important as these provided the material for the classic experiments by Ridley and Derry.

Meanwhile the trees at Kuala Kangsar had flowered in March 1880 and set seed the following year. Mr. (later Sir) Frank Swettenham, acting for Low in 1884, planted out about 200 seedlings on the banks of the Perak River and on the hill behind, where the new Residency was built. A group of seedlings was planted around the grave of British soldiers killed in the Perak expedition of 1876. These proved a valuable source of seed in later years.

The Search for a Means of Exploitation

The first tapping in Malaya was on the Kuala Kangsar trees by aborigines; they used an unsuccessful incision method probably similar to that employed to extract poisonous sap from the Ipoh tree. It is not clear when this was done, as some of the early literature is contradictory and includes evident typographic errors in the dates. Low is reported to have sent rubber samples to London

in 1884, which were not received favourably, but these may have been Ceara Scrap (from *Manihot glaziovii,* which was also planted at Kuala Kangsar); at any rate the confusion did not enhance the reputation of cultivated rubber. Swettenham may have directed an attempt in 1886 and—or—Low an attempt in 1888.

Another attempt was made in 1889 when Swettenham had succeeded Low and the results were again disappointing. Swettenham, having decided that there was no future for *Hevea* in Malaya, ordered the destruction of several of the original Kuala Kangsar trees and discouraged further interest. This remained the view in government circles for some years.

The year 1888 marked the arrival in Singapore of Mr. H. N. Ridley as Director of the Botanic Gardens. He shared Hooker's faith in natural rubber production by *Hevea* cultivation and, despite government opposition and lack of funds, set about rehabilitation of the Economic Gardens and experimented to find a practical means of extracting latex. As early as 1889, while Swettenham made his gloomy predictions, Ridley made his first basic discovery.

Hitherto virtually all forms of and attempts at tapping *Hevea* for latex were incision methods, by which a cut was made through the bark but no bark was removed. (We use bark here in the popular sense to denote all tissues outside the wood). Incisions tend to close, there is no proper channel for the trickle of latex to flow along into a receptacle and it is hard to judge the depth of the cut—the result is much wounding of the tree.

The *excision* method invented by Ridley involved removal of a paring of bark from the cut, which in the first place overcame the main defects of incision noted above, but lead to the further discovery that by repeated paring away of bark from the one cut at intervals a greater flow of latex could be stimulated. Rubber obtained by this method was exhibited at the Singapore Agricultural Exhibition in 1890 and samples were sent to London the next year, where they were pronounced excellent. Other members of the Gardens staff joined in the tapping experiments, C. Curtis in 1896 at Penang, L. Wray in 1897 at Taiping and R. Derry in 1898 at Kuala Kangsar, whence rubber was sold in 1899; the various botanic gardens in Malaya were then all under the direction of Singapore.

In 1904 Derry joined Ridley in Singapore and together they conducted a series of experiments, which established a number of principles and carried the technique far towards that currently employed. Mr. A. D. Machado and Mr. C. Boden Kloss assisted in the experiments and yield recording during some years. Only the main trends are described here to illustrate the progress made.

The first tapping was done with a pruning knife, chisel and mallet but these were superseded by a modified farrier's knife or gouge, a form of which was adopted on one of the first plantations —Jebong Estate—and the "Jebong" is still among the most useful tapping implements. The advantage of morning over afternoon tapping was first established at Singapore. The relative performance of wide- and close-planted trees was investigated; the conclusion was reached that a relatively wide spacing giving a stand of 150 trees per acre would give more economic tapping and a longer useful life than much denser plantings.

The arrangement of the cuts fell into two patterns: (i) herring bones, in which sloping lateral cuts branched upwards from a central vertical channel and (ii) spirals encircling the tree several times. The Singapore workers soon abandoned the more fanciful systems, and although they do not seem to have reached the ultimate simplifications, i.e. neither reduction of a double fishbone to a single V-cut and of a half fishbone to a single half spiral, nor restriction of the number of turns in a helical cut to one full or half circumference cut as now, their conclusions were moving in that direction.

At first there was much apprehension that if tapping were continued too long, the bark would not renew over the ever extending area of excision. Ridley and Derry grew bolder as their experience confirmed that continuous tapping—indefinitely repeated excision at regular intervals—was possible, the bark renewed and moreover greater yields were induced. The simplification of the original herring bone was largely to allow adequate time (four years was at first thought sufficient) for bark renewal before one cut encroached on the next under continuous tapping. They compared daily and alternate daily tapping and expressed a preference for the latter.

Changing Interests and the First Plantations

The tapping experiments described above continued until 1909 and we must revert to the period immediately after Ridley's discovery of a practical method of exploitation to carry on the general history of the subject. The depredations of disease were rapidly making coffee cultivation uneconomic and the owner-managers of the first estates were looking for alternative crops. At first Ridley was still a voice crying in the wilderness as far as rubber was concerned, some of his critics referring to him openly as 'mad' Ridley. Although some planters such as Mr. Hislop Hill and the Kindersley brothers continued to plant scattered trees of *Hevea* for observation and to provide seed should the crop realise its potentialities,

the first plantation development was the planting of 40 acres of *Hevea* by Mr. Tan Chay Yan at Bukit Lintang. There is some confusion about the date of this. Ridley has stated 1896 but some later authors quote 1898. One of the Kindersley ventures in 1895 is reputed to have been virtually a plantation of *Hevea*. Mr. Tan exhibited rubber in 1898, presumably prepared from his older parent trees and not from the 40-acre block. At any rate this was the turning point; there had been little interest before but now Mr. Tan went ahead with a larger planting at Bukit Asahan and many other planters followed suit.

The decline of coffee cultivation, the increasing demand for and price of rubber on the world market were important factors: nevertheless Ridley's discovery of excision tapping and persistent propaganda were essential contributions.

We must note here that Murton's choice of two sites, Singapore and Kuala Kangsar, for the first introductions had several important results relating to the rapid expansion of plantations. Mr. Cross, who made an unsuccessful shipment of seed from Brazil to the East, had stated that damp, swamp soils were the best for *Hevea,* especially land subject to flooding. Wickham had in fact collected his seed from an undulating plateau probably with a well drained soil, which he confirmed in 1902. However, unsuitable water-logged sites would probably have been chosen for many years if Murton had not established the Kuala Kangsar trees on what would now be recognised as a typical soil for *Hevea,* i.e. moist but well-drained. Thus the range and suitability of habitats for *Hevea* in Malaya was demonstrated by this and subsequent early plantings at Kuala Kangsar, Taiping and elsewhere by Low, Swettenham and Hill.

Furthermore these trees provided a local source of seed for North Malaya, some of which were planted by Hill in Negri Sembilan, and in 1893 he had seed available in quantity. Seed was despatched to the many new plantations in Malaya and other territories; Ridley had found that the best packing for long distance travel was damp charcoal in sealed biscuit tins.

Research and Advice

The new development raised many problems, first in cultivation and later in processing of the crop—in other words there was a need for research and advice. This had been anticipated by Ridley and his assistants, who had devised means of coagulating latex for shipment and studied conditions of tree growth and many diseased specimens.

As early as 1891 the first Agricultural Bulletin had been published; but owing to lack of funds and delays at the Government Printing Office this did not appear regularly until 1901. When Ridley was preparing to depart in 1911 and it appeared that publication might cease, the Planters' Association of Malaya pleaded that his successor should continue it, remarking that 'Ridley's contributions have been highly valued by the Planting Community and it would be a distinct loss if the Bulletin were discontinued.' Feeling towards 'mad' Ridley and the other rubber enthusiasts among his colleagues had changed considerably over twenty years. When leaving Malaya Ridley left pleas in the Agricultural Bulletin and Greniers Rubber News for an expansion of research and advisory services.

By this time the Department of Agriculture F.M.S. (founded 1905) had assumed responsibility for investigations on rubber, although there had been a transition period during which the experience and current experiments of the Gardens' staff were available until the new Agricultural staff were conversant with the problems. For instance the Singapore Botanic Gardens was for many years among the few institutions with an adequate number of trees in tapping for experiments on the preparation of rubber from latex; Ridley had made the first 'biscuits' of rubber coagulated in shallow plates and Derry continued for many years to make improvements in processing, including coagulation, sheet and crepe manufacture.

We will review here only the contributions made by the Gardens' staff—in particular Ridley's. There was activity along parallel lines elsewhere, particularly in Ceylon and Java, the importance of which we do not wish to ignore or gainsay; moreover the Gardens enjoyed the collaboration of Mr. P. J. Burgess, the Government Analyst, who made several contributions on tapping, coagulation and processing. Nevertheless the extent of activities and number of first records by the Gardens' Staff adequately illustrate their preeminence in this field.

Pests and diseases are always among of the first difficulties encountered in new crop culture. Termites were the first insects to trouble *Hevea* in Malaya; apart from 'plantation hygiene'—which was only partly helpful—Ridley was unable to solve this problem. However, the full control of termites has had to await the discovery of modern insecticides. Crickets and mites appeared in due course; for the latter Ridley and Derry recommended sulphur dusting.

The white and brown root diseases of rubber were first described in 1904 and 1909, respectively, by Ridley who advocated detection

and destruction of sources of infection. He reported on 'pink' disease of the stem and branches in 1905 and advised destruction of diseased tissue and treatment with copper sulphate and lime. Birds eye spot was recorded as an emphemeral disease of young seedlings in 1906. The present-day planter will be struck by the small changes in the principles of disease control recommended today and those suggested by Ridley.

The first report on the deleterious effects of applying lime to *Hevea* was made by Ridley in 1903, when he conducted a manurial trial.

Prophecies and Warnings

The early planters were, almost without exception, keen advocates of clean weeding; the majority would not tolerate any catch crop which might deter from the main crop nor any cover crop for soil protection. During the first decade of the century many planters had adopted the practice of eradicating all plant growth by spraying sodium arsenite repeatedly. Ridley saw further and especially in his last editorials addressed serious warnings on the risks of soil erosion to the plantation managers. He suggested chillis, pineapples, bananas and bowstring hemp (an agave) as possible catch crops, which—except the last—can all be seen put to good use on small properties today especially by Chinese. Tapioca, the catch crop favoured by the minority group of 'maximum exploitation—minimum time and effort' planters, was considered by Ridley to be liable to exhaust the soil and to spread root disease; therefore he advised caution and experiment before using tapioca as a catch crop, which attitude has been amply justified. In 1910 Ridley prophesied that contour terraces would be necessary to control erosion on slopes and that cover crops such as the local wild *Crotalaria* would be needed for soil protection and enrichment. He realised that not all lands were suitable for rubber cultivation and condemned planting *Hevea* on deep peat soils.

We note too that Ridley advised against cutting out coconuts in order to plant rubber, stating explicity that neither individual estates nor the country should rely exclusively upon one crop. He was one of the first to suggest the oil palm as a plantation crop and distributed over 3,000 seeds.

There have been and there are—as there should be—critics of the unbalanced state of Malayan agriculture, meaning in particular the predominance of and dependence on rubber. Critics of the plantation industry have pointed to clean weeding and other bad practices of the early planters, whose rapacious exploitation of the

soil has bequeathed us many problems in its rehabilitation. Nevertheless, these critics should realise that the practical founder and advocate of the rubber plantation industry—Ridley—warned against these errors; indeed the slump of 1913 came as an early reminder of the risks involved in dependence on one crop, but neither the sound business men nor officialdom took much heed. Ridley was ably assisted and—perhaps to greater extent than we realise—guided by a team of Gardens' staff in Singapore and throughout Malaya, who were all devoted to the study of plants and fully appreciative of their value in preserving and developing the resources of the land they had come to serve.

We come now to the close of the period during which the Singapore Botanic Gardens were directly responsible for the development of the rubber industry in Malaya. Mr. I. H. Burkill became Director in succession to Ridley in 1912. Rubber development had then become entirely the responsibility of the Department of Agriculture. Yet Burkill maintained tapping of the *Hevea* at Singapore and yield recording of the individual trees, so that the most productive could be selected as seed parents for future improvement of planting material.

The Present Situation

In 1926 the Rubber Research Institute of Malaya was created by enactment and in turn took over responsibility for rubber. The Botanic Gardens have continued with the basic studies of systematic research into the Malayan flora and the nature of the vegetational formations in the region. It might seem that we have gone our separate paths and the Botanic Gardens are of no further service to the rubber industry, but such a view ignores one of the greatest problems still lacking a solution. We need the help of the fundamental botanist, who is found in institutions such as the Botanic Gardens, which we wish well—not for sentimental reasons because of the great contributions of the past—but in expectation of further assistance in the future.

Malaya and most of the other countries where *Hevea* is cultivated lie in the region of the tropical rain forest. This type of vegetation is very complex; frequently over one hundred different tree species are found in a single acre of Malayan jungle with even more species amongst the epiphytes, lianes and ground flora. The rain forest has developed and perpetuated itself for millenia, but the whole formation is now rapidly disappearing under the pressure of man's advance before he has discovered how it functions.

This state of affairs has been frequently acknowledged recently, for instance at the Ninth Pacific Science Congress, Bangkok, 1957, at the Centenary and Bicentenary Congress, University of Malaya, Singapore, 1958, and at the UNESCO Symposium on Humid Tropics Vegetation, Bogor, 1958. Every appreciation of the situation emphasises that the effects of rain and insolation on exposed tropical soils can lead to rapid impoverishment and erosion. Phosphate availability in most Malayan soils is notoriously low and other nutrients are easily leached out of disturbed soil; there are indications that these can be alleviated or prevented by a suitable vegetational cover which maintains the organic content of the top soil. Such vegetation controls physical erosion and through its many members circulates nutrients also.

Copious rainfall, constant warmth and generous irradiation with sunlight are all factors which contribute both to rapid plant growth and to rapid soil degradation. The success of the tropical rain forest derives from its ability to use the benefits of these factors to provide a luxuriant vegetation on generally poor soils, despite the deleterious potentialities due to these same factors. The object of agriculture in the tropics is to produce a luxuriant crop without soil degradation.

Although the agriculturalist can apply fertilisers to make good losses and deficiencies and can use physical means such as terraces and water channels to control erosion and water distribution, basically he has to solve the same problems which the forest has surmounted. This will probably be achieved most effectively and economically by the same means as those which are successful in nature; it is unlikely that totally different principles will succeed where we must contend with tropical climate, poor soil and undulating terrain.

A single crop culture, even in association with a cover crop which is often limited to a narrow spectrum in floristic composition and growth form, is unlikely to perform all the functions carried out by the natural forest vegetation. Plantation crops such as rubber will continue to be grown in stands of one crop because this enables more economic cultivation and harvesting. Nevertheless there is a need to enrich the ecological association of these crops by introducing into the cover further elements which can fulfil the processes of soil conservation. Currently we are approaching this problem by growing various plants in association with the main crop and endeavouring to assess their effects upon the main crop and upon the soil. However, we would be better guided in our choice of plants and factors to study if we knew how the natural tropical rain forest functions.

The Future

It is often stated that the future of the natural rubber industry depends upon reducing the cost of production; nevertheless if the existing advances, especially in the selection of planting material of improved yield, are exploited fully, as is attempted in the current replanting programme, a production cost competitive with synthetic rubber can be achieved. Further research will be necessary to keep the cost of production down to this level despite rising wage trends and possible cheaper synthetic production. In the preceding section we envisaged an ideal tropical agriculture harnessing the natural processes of the forest; such a system for rubber cultivation would doubtless form a valuable contribution towards the long term reduction of production costs, but would moreover preserve the fundamental asset—the soil itself. Investigations on the functioning of the tropical rain forest have scarcely been essayed, yet this is a most important field both for its scientific interest and in order to evolve a rational form of agriculture for land utilisation in the tropics. The scientific manpower available is limited but the destruction of the forest is continuing apace. No one institute can tackle this problem alone, because the facilities built up over long periods such as herbaria, experimental gardens and forest reserves of known history and laboratories proper to different institutes are all needed. Moreover scientists trained in various disciplines who have experience in institutes devoted to every branch must co-operate in this undertaking.

The Departments of Forestry and Agriculture in the Federation of Malaya are daughters of the Singapore Botanic Gardens and the Rubber Research Institute is in effect a grandchild. Within this family there is scope to tackle the fundamental problems of tropical ecology; may the centenary of the Singapore Botanic Gardens be marked by revived interest in this subject. The difficulties which we have inherited and the problems we may bequeath owing to poor land management will be best solved and prevented by this means.

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The Contribution to Agriculture in Malaya by the Singapore Botanic Gardens

By a Malayan Agriculturist

A GARDEN: A piece of ground where flowers, etc. are cultivated. A pleasant spot. (*Chambers's Dictionary*).

THE SINGAPORE BOTANIC GARDENS are a very pleasant spot indeed and a good place to relax. So much so, that the casual visitor would have no idea of their importance to Malayan agriculture and the valuable scientific research that is carried on there.

It has been said* that the experimental and scientific work in a botanic garden "cannot by its very nature be directly remunerative but may indirectly repay its cost many times by establishing new industries, by saving old ones from losses by disease or otherwise, introducing new and improved methods and so on". The validity of this statement is well demonstrated by development of the rubber industry in Malaya, but even if this were not so, even if rubber had failed to grow here at all, the Botanic Gardens have made many other less spectacular but nevertheless notable contributions to Malayan Agriculture.

In the first place it should be recalled that when the Gardens were taken over by Government in 1875, it was intended that they should be concerned with agriculture and the economic development of the Straits Settlements and not merely a pleasure garden or a base for collecting material for the Botanic Gardens at Kew in England. The Director of the Gardens was also the Director of the Forest Department and regarded, by the Government at least, as the pre-eminent authority in Malaya on anything whatever concerned with plants.

Starting in 1891 a Bulletin dealing with Agri-Horticulture, and other cognate subjects, was published by the Gardens and this was issued as a monthly journal from 1901 to 1911. (*Agricultural Bulletin of the Straits and Federated Malay States*), Opening Volume I of this Journal at random one may find articles on rubber cultivation, a series on the Timbers of the Malay Peninsula, Trade and Market Reports and, among the correspondence, a letter from Mr. Carey claiming that coconuts will yield well on the coastal clay soils of the West Coast. Even today, the scientific reports are of

* J. C. Willis, 1907.

value and although the price of opium (11*s.* 6 *d.* per lb., spot) and Mr. Carey's well justified optimism are only of historical interest, one can appreciate how this Journal must have made up for the lack of communications and expert advice to which we are now accustomed.

The Bulletin continued to be published even after a Department of Agriculture for the Federated Malay States was set up in 1905, but its name was changed to the *Gardens Bulletin* in 1912 when the F.M.S. started to produce its own agricultural magazine. In 1919, the Department of Agriculture, F.M.S., also took over the responsibility for agriculture in the Straits Settlements, and the *Gardens Bulletin* gradually began to put less emphasis on practical agriculture until 1924 when this aspect of the Garden's work finally came to an end.

This is not to say that the Gardens' staff were no longer interested in agriculture. The Economic Gardens of 102 acres had been opened in 1879 and used as a preliminary trial area for numerous local and introduced plants which were considered to have some potential value. In addition to rubber, it is worth noting that the first oil palms in Malaya were planted there about 1875 and an excellent review of the possible value of these palms in Malaya was published in the *Bulletin* in 1907. The Economic Gardens were unfortunately closed in 1925, but despite this I. H. Burkill was able to publish his *Dictionary of the Economic Products of the Malay Peninsula,* which is still in every-day use as a reference book at the Department of Agriculture in Kuala Lumpur and all over the world. Other books which have been invaluable to agricultural research and have an international reputation include the floras by Ridley, Holttum and Henderson and the well illustrated two volumes on *Wayside Trees of Malaya* by Corner.

It is our good fortune that the work of the Gardens has been so well documented but no library, however comprehensive, could replace the collection of living and preserved material which is available there. The value of these specimens to the teacher, the student and amateur gardener need not be mentioned here, but to the scientist from tropical and sub-tropical countries, the herbarium type specimens and the easily accessible living material, form an invaluable point of reference. For instance, when the Department of Agriculture was recently anxious to learn the types and distribution of citrus trees growing in Malaya in order to prepare a scheme to improve the planting material of this crop, the Plant Breeder first visited the herbarium at the Gardens and was not only able to gather much of the information he required but was also able to clear up some difficulties over citrus taxonomy in general.

Difficulties are, in fact, quite frequently encountered by anyone concerned with taxonomy and since this is a science in itself there is a small traffic of specimens from Kuala Lumpur to the Gardens for identification.

It would perhaps be appropriate to emphasise here how useful it is for the agriculturist to know the correct botanical name for a plant he is growing. It would be useless for anyone wanting oil palm seed to write to West Africa asking for seed of "kelapa bali" or "kelapa sawit" but if the palm were given its accepted botanical name, *Elaeis guineensis,* the type of seed required would be clearly understood. Similarly root-disease of fruit may be due to a number of causes, but if the plant pathologist can isolate and identify, say, the fungus *Phytophthora citrophthora* from the diseased roots, he can at once be almost certain that he has found the cause of the trouble, and can consult the literature describing methods for controlling this same fungus in other parts of the world.

Until, perhaps, electronic translating machines are invented, it is too much to hope that scientists throughout the world will publish all their works in a universal language. For the moment we must be thankful that Linnaeus invented his binomial system for naming plants and animals. Without this system, and the support of institutions such as the Singapore Botanic Gardens, which are mainly responsible for its propagation, there is no doubt that agriculture would be immeasurably the poorer.

Orchids, Gingers and Bamboos: Pioneer work at the Singapore Botanic Gardens and its significance for Botany and Horticulture

By R. E. HOLTTUM

Director, Botanic Gardens, Singapore 1925–1949

A BOTANIC GARDEN is essentially a museum of living plants maintained for botanical study. Out of that study comes new knowledge of various kinds, much of which can find an application in horticulture.

The maintenance of any garden involves thought about horticultural technique; and the maintenance of the great variety of plants in a botanic garden should result in experiment in techniques and in new understanding of the diverse cultural needs of the many plants concerned. Thus in a botanic garden there is a two-way traffic of knowledge and its application; new botanical knowledge finding applications in horticulture, new horticultural techniques aiding the cultivation of plants for botanical study.

A botanic garden may serve also as a park, but that is not its primary function. It should be the source and storehouse of new knowledge, both horticultural and botanical, which can find its application in parks and in private gardens; and without that constant pursuit of new knowledge the parks and gardens lose the impetus to progress.

Botanical study possible in botanic gardens may be divided broadly into two aspects: study of the structure and classification of plants, and experimental work of various kinds. The study of classification is basic to all other, and I would regard it as the primary function of a botanic garden. Such study may seem very theoretical; but it has immediate application in plant breeding and also in other ways. Plant breeding is one kind of experimental work which may be undertaken at a botanic garden; it can provide new kinds of plants for horticultural use. Other kinds of experimental work are concerned with the physiology of plants, and such may result in new knowledge useful in horticultural techniques.

The orchid family is the largest plant family (in number of species) in the Malayan region, and includes many beautiful plants which are valued horticulturally. Botanically, the great variety and complexity of floral structure presents very intricate problems to

the classifier. The botanist who explores the forests of Malaya for orchids (or other plants) cannot make a final study of them as he finds them; he needs to take them away for more detailed examination at leisure. He may either preserve them as herbarium specimens, or he may take living plants for cultivation. The herbarium at the Botanic Gardens, Singapore, is thus a vast storehouse of information, much of which has still not been thoroughly investigated. For orchids it is much more satisfactory to have living plants in cultivation, and to examine the fresh flowers, as dried ones lose some of their characteristic shape as well as their colours.

Mr. H. N. Ridley, who was Director of the Gardens from 1888 to 1912, had made a special study of the orchid family before his arrival in Singapore, and during his many travels of botanical exploration he brought to the Gardens a large number of orchid plants, many of which he described as new species, preserving also specimens of them. He also had the services of an excellent artist (Charles de Alwis) who made accurate coloured drawings of the plants and their flowers. Thus the records of Mr. Ridley's study of native Malayan orchids are preserved in Singapore in the form of specimens, illustrations and descriptions. Upon these records depends stability in the use of names; if a name is to be useful it must always mean the same thing.

Similar work on orchids was carried out in neighbouring countries (India, Siam and Indo-China to the north, and in Indonesia). In order that there shall not be confusion and duplication in the use of names, it is necessary to correlate study of plants in Malaya with those in the surrounding countries (where many of the same species occur, along with others). This has been achieved by the accumulation in Singapore of a valuable botanical library and by exchange of specimens.

The most important later collector and describer of new orchids in Malaya was Mr. C. E. Carr, a rubber planter who made this work his chief recreation. He used the herbarium and library at the Botanic Gardens, Singapore, and contributed specimens which he had gathered. After his death, his many manuscript notes and drawings were also acquired for the Gardens, and are a most valuable record of his work.

In this kind of way a great body of records concerning the native orchids in Malaya and neighbouring countries was built up. Much of this recorded knowledge became of great importance when the breedings of new orchids, for use as garden plants and for their cut flowers, was begun about the year 1928. It is true that only a

small proportion of orchid species are useful for exploitation in this way; but for a proper appreciation of the possibilities, the full survey is necessary, showing the more useful plants in perspective as parts of a whole, and thus showing their own inter-relations. Such a survey also shows what other plants exist, not yet in cultivation, which might be valuable for breeding purposes.

The impetus to orchid breeding was provided by Mr. John Laycock, who imported to Singapore many species from neighbouring countries, thus providing valuable breeding stock, and by a visit from Prof. H. Burgeff, a pioneer of the study of orchid seedlings. Up to that time, no orchid seedlings had been raised in Singapore by modern methods of pure culture which ensure a high percentage of germination; and nobody had any experience of the behaviour and cultural needs of young orchid seedlings newly removed from culture tubes. As a result of trials and errors, methods of dealing with these plants were gradually discovered, and the first seedlings flowered in 1931 (Spathoglottis × Primrose). A succession of new hybrids followed, and at the time of the Japanese occupation of Singapore some 4,000 seedlings were in pots at various stages of development, in addition to those in flasks and to larger plants. A considerable proportion of these plants was maintained during the occupation period, though there were many losses, and some new crosses were made. Methods of raising seedlings on agar-agar prepared directly from seaweeds were developed. Progress after the war was rapid, and today the production and culture of fine new orchids has become of considerable commercial importance, as well as a recreation for a large number of people.

The significance of this development is that nature provides comparatively few kinds of orchids well suited to the local climate in vigour of growth, and in freedom of flowering, which have also the qualities of floral form and durability required for horticultural purposes. The production of large numbers of new kinds of plants by crossing, by new seedling techniques, and by selection of the best, has resulted in a complete transformation of Singapore gardens, and in the production of a wealth of cut flowers throughout the year in considerable variety, and of kinds previously unknown. It is an example of the kind of change which is possible also with other families of plants.

The Ginger family provides a rather different story. There are about 150 known species of the family in Malaya, most of them wild in the forests, a few others being cultivated in villages for flavouring food or for medicine. Nearly all plants in the family have aromatic properties, and more of them are potentially useful

than are yet in use. Little or no breeding or selection, even of the kinds now in use, has yet been undertaken. The family has its main centre of distribution in Malaysia, and the only full botanical monograph upon it was prepared fifty years ago, in Europe, from imperfect material. This monograph is very unsatisfactory, and a careful study of native Malayan species, made in recent years at Singapore, led the way to revised concepts of basic classification. This study was possible through field and garden work similar to that undertaken for orchids, as above described. The flowers of the ginger family are delicate and short-lived, and also complex in structure, so that dried specimens are difficult to interpret; one needs to see either fresh flowers or specimens preserved in alcohol. The revised survey of the family in Malaya gives a full statement on classification as well as detailed descriptions of all species known to occur in the country. It was in part based on pioneer studies made of some allied species in Java; and in its turn the Malayan survey has helped in the understanding of other Indonesian members of the family. This study, made in Singapore through a combination of botanical and horticultural activities (especially the collections of plants and specimens made by Mr. E. J. H. Corner) is basic to any future exploitation of this family, which contains so many useful plants.

Bamboos are used daily, for many purposes, by almost all people in Malaya; there are no other plants which have such varied uses. But until recently no descriptive account of the various kinds of Malayan bamboos had been published. The reason is that there are many peculiar difficulties in the botanical study of bamboos. In the first place, botanical classification must be based on floral structure, and most bamboos flower rarely (one plant from northern Malaya, in cultivation in Singapore for fifty years, has never been known to flower). Thus it is obviously necessary also to study other parts of the plants, so that recognizable descriptions, based on the non-flowering parts, may be drawn up. In practice, such descriptions are not easy to make, and no real attempt to make them was tried in Malaya until quite recent years. This attempt was only possible because from time to time native Malayan bamboos of various kinds, and also species from India and elsewhere outside Malaya, had been brought into cultivation in the Botanic Gardens, Singapore. These plants were available for detailed study at leisure, and their flowering could be observed when it occurred. As a result of such study, further field work could be effectively carried out, and resulted in more plants being brought into cultivation, as well as in specimens and in recorded observations on plants found in various parts of Malaya.

The results of this first survey of Malayan bamboos, made possible by the cultivation of plants in the Botanic Gardens, Singapore, have now been published. It is hoped that this publication may be made the basis for a comparative study of the useful characters of Malayan bamboos. In the north of Malaya there are many kinds of native bamboos which have never been brought into cultivation, and there have been no experiments to test the usefulness of particular kinds of bamboos for different purposes, or to select the best kinds for propagation and wider use. Here is a subject which touches the daily lives of all people living in the rural parts of Malaya, basic work on which has been carried out at the Botanic Gardens, Singapore, and which awaits that further investigation which is outside the scope of the Botanic Gardens.

Singapore's Contribution to the Study of Palms

By C. X. FURTADO
Botanic Gardens, Singapore

BOTANICALLY PALMS are considered as the "Princes" of the vegetable kingdom, but they are also important economically. In some cases like the coconut palm it is possible not only to make a boat out of the timber but also to provide it with ropes, sails, cloth, flour, oil, sugar, wine, vinegar, spoons, brushes, brooms, drinking vessels, etc. all derived from the palm itself, showing thereby a variety of uses some palms have. Others like the *Nibung* made the Malaysian civilisation possible since its timber was needed not only for the boats but also for the houses, for no other cheap timber was available that could stand salt water and also resist the attack of termites and other destructive organisms. Similarly were it not for the leaflets of the two palms *Nipah* and *Rumbia* (Sagu), Malaysians would have experienced great difficulties to find for their houses and boats suitable attaps that would resist weather and the destructive action of white ants and other insects. Much of the sugar that was available to the original Malaysians in lowlands was derived from coconut and Kabong palms, since sugar cane could not be grown without being protected against the ravages of wild animals. The "dragon-blood" which was formerly exported to Europe and elsewhere for medicinal and other uses, was derived from some species of climbing palms known as rattans or rotang, a group of palms that provide what is commercially known as the Malacca cane used for making walking sticks, wicker chairs and other articles.

Now every species of a particular genus of plants has different properties and uses. This is one of the reasons why systematic botanists keep themselves busy in studying the characters by which different species and varieties of plants might be recognized. Systematic studies help to correlate the results of research workers in different branches of science or knowledge. Thus a dietician or nutritional chemist will want to classify the results on the different vegetable products used in the diets of the people, the pharmacist to know the plants used as medicines by the aborigines or the rural people; the police to know the plant poisons used in murders, suicides and other crimes; the veterinary officers to know the different kinds of plants used to feed, to poison, and to cure the animals; the fisherman to know the small plants that help the fishes

in pisciculture; the malaria controllers to know the plants that encourage or hinder the propagation of the mosquitoes; the silviculturists, the trees that yield the timbers suitable for different purposes, and so on. The systematic botanist is therefore an indispensable person for research workers and commercial men who have anything to do with plants or their products.

To classify plants that are not microscopic a large collection of dried specimens to illustrate the leaves, flowers and fruits as well as the natural variation between these is necessary, for only with a carefully preserved material in herbarium can a systematic botanist concentrate to detect the characters that distinguish one species or variety of plant from another. The need for such a collection is easily satisfied in case of plants which have fairly small twigs, leaves and fruits. But in the case of palms the difficulty is often a formidable one, both for the field botanist who collects the specimens in the field and for the systematist who arranges and studies the material in the herbarium. Many palms have large leaves and their stems are very bulky too. If one were to collect only one leaf and flowering branch of a large palm, they would form a great load for a person, whereas within the time and labour several dozens of specimens could have been made of large trees having small twigs, leaves, flowers and fruits.

Palms also show a good deal of difference in age. The leaves produced when the plants are young and not flowering are often completely different from those produced by a flowering stem. Further an inflorescence might appear completely male at one stage and completely female at another stage. Moreover in the early stages of flowering of a palm that produces both male and female flowers on the same spadices, often no female flowers are produced so as to make one imagine that the sexes are distributed on different plants.

In case of rattan palms, additional difficulties occur often in the better varieties that produce long climbing stems. The long, hooked whips which enable the plant to climb can entangle a collector tearing his clothes and wounding his skin in a way that it may be difficult to extricate him unless armed with a sharp knife. Since such climbing rattans produce flowers and fruits only when they reach to a great height on the trees which they climb, it becomes impossible to get fertile specimens essential for the herbarium except by cutting the rattan; but since the rattan does not climb straight and since the hooked whips are sometimes 15 ft. long or more and the hooks are reversed, it is not possible to pull such a rattan down even with a force of 10 to 15 men. Several times I

have had to fell 7 to 8 trees and treelets before getting the specimens of one rattan. Further all rattans have thorny sheaths on the leafy stem and the leaves themselves are also armed with hooks. This means that one has to use leather gloves and handle the whole material with care lest it injures the hands and fingers.

Now having obtained a rattan plant, how is one to make the specimens since each leaf or spadix is very large? In the early days when forest officers knew little about collecting palms, the Berlin palm specialist wrote to a forest officer in New Guinea to send him a good specimen of a palm that looked to be a new species though well known to the aborigines. The silviculturist immediately got his men active. He cut a palm with 30–50 ft. tall trunk and 18 inches thick, and had his men transport it to the nearest port whence the plant was shipped to Germany. On its arrival in Hamburg special arrangements had to be made in order to transport it to Berlin, and it was kept in the Museum for the benefit of the school children. But since during the transport the flowers and fruits were lost, the specimen was useless for a botanical study, though several hundreds of dollars were spent in getting the specimen from the jungles of New Guinea to the Botanical Museum of Berlin!

This digression will help to emphasize the need for the botanists to study the palms in living state in order to decide what parts are essential to enable him to distinguish the one species or variety of rattan from another, that is, the specimens that will not burden unnecessarily the collector and that, without occupying unnecessary space in the herbarium, will provide the necessary distinctive clues to the systematist. In this regard the observations made by the botanists in the field as well as on the plants grown in the Botanic Gardens of Bogor and Singapore have provided useful clues for making satisfactory specimens. And as far as the Malayan rattans are concerned, the Botanic Gardens of Singapore may be given the credit of having played the major role in the classification of the rattans, having secured in the initial stages the help of the great palm expert, the late Dr. O. Beccari of Florence, Italy, who had also studied the palms in the forests of Borneo and New Guinea and those collected by the staff of the Botanic Gardens of Bogor and Singapore.

In the course of these studies the status of several doubtful ones has been cleared, some passing under two or more names because of some variation due to age or ecological conditions have been merged into one, several new species and varieties have been described and the generic distinctions have become better understood. In 1907, for instance, Ridley who, as said above, had enlisted

the help of Professor Beccari of Florence, described in his *Materials* 86 species of rattans under 6 genera, of which 16 species were new, that is, in addition to those new species described by Beccari from the specimens collected by the Singapore Gardens' Department. Later in his *Flora of the Malay Peninsula V* (1925) Ridley described 94 species of rattans (with 5 new species) under 7 genera. In 1951–56, Furtado described and illustrated in the *Gardens' Bulletin,* Singapore, 127 species of Malayan rattans under 10 genera, of which one was a new genus and 28 new species and several varieties and new records of species previously known only from non-Malayan regions.

However the study of the Malayan palms is not yet complete. A proper field survey of all the palms is needed in order to build up an adequate herbarium in Singapore, and in this the co-operation of the Forest Officers is valuable, since they make frequent trips to the jungles and can make valuable collections whenever a coupe is felled for timber. If a comparative systematic study were made of the palms from the Malaysian region including Assam, Burma, Lower Siam, Malaya, Sumatra, Java and the neighbouring islands, it should yield much valuable knowledge of the palm genera and species occurring in this region, their distribution, and the range of intra-specific variation and other characters.

Manila and the Singapore Gardens

By EDUARDO QUISUMBING
Director,
National Museum, Manila

THE NATIONAL MUSEUM of the Philippines, in Manila, greets the Singapore Botanic Gardens on the occasion of its centenary. We in the Philippines, who have immensely and continuously profited by its goodwill and co-operation, have every reason to feel proud of its achievement.

For the last 100 years, the Singapore Botanic Gardens and Herbarium have been known as institutions which are not only useful to Malaya but to all scientists the world over. While both have served as places of recreation and education for the people of Malaya, they have contributed their own share in the dissemination of plant knowledge and distribution of plant species to all parts of the world. The Herbarium itself is well known for its valuable collections and adequate library and serves as a seat for research and study of the flora of Malaya.

Many famous names have served as directors of the Gardens and many of its botanists have made invaluable contributions not only to the flora of Malaya, but also to that of Malaysia. Their works appear in the *Gardens' Bulletin,* which, likewise, has been considered as an invaluable scientific publication.

Our first scientific contact with the Singapore Botanic Gardens was established after the year 1910 by the late chief botanist (later director) Dr. Elmer D. Merrill, of our Bureau of Science. He had started the exchanges in botanical knowledge as well as in botanical specimens, which are equally valuable to both institutions. This co-operative work was continued by me after 1923 when Dr. Merrill left the Philippines and I became an official of the Philippines National Museum, which handles botany as well as all divisions of natural history. Besides our exchanges of specimens we also exchanged our publications—the *Gardens' Bulletin* for the Philippine *Journal of Science,* and *vice-versa*—and loaned Philippine and other Indo-Malayan mounted herbarium material to Malayan specialists for their study of Philippine representatives of various plant families or for their preparation of monographs on botanical groups.

It is a pleasure to recall at this time my personal visits to the Gardens—one in August 1928 and another in November 1938. From this latter visit I brought home with me some cuttings of the various varieties of bougainvilleas and a seedling of *Lagerstroemia floribunda*. The former now adorns the gardens of Malacañang, official home of the President of the Philippines, while the latter is a full-grown tree now serving as a graceful ornament in my private garden. The late Mr. Wester also brought many ornamentals from the Singapore Botanic Gardens.

The Singapore Botanic Gardens was and still is the centre of botanical work on the Malayan flora, just as Manila was and is for the Philippine flora. Despite the complete destruction of our herbarium during the war, the Philippines is at present in a position to begin—as it has already begun—to rebuild its collection and regain its place in its own field.

With such thoughts as the above on our past contacts and exchanges and close associations and co-operation in our particular branch of science, the centennial celebration of the Singapore Botanic Gardens has become truly significant to us. It is my hope that we can continue to carry on our present harmonious relationship for the mutual benefit and satisfaction that such relationship can bring us.

The Botanic Gardens and Conservation in Malaya

By H. M. BURKILL

Director,
Botanic Gardens, Singapore

RESOURCES are not only fodder for industry but include the matériel for man's existence and his mental and physical well-being. Conservancy is a rational policy to avoid wasteful destruction of resources, to ensure that what is renewable, such as plant and animal life, is not utilised (destroyed) beyond its capacity to maintain itself, and to put land to the best possible use for the country, thus avoiding conflicting demands on it.

The Botanic Gardens have been involved in various conservation projects which have contributed very significantly towards the development of modern Malaya*. The most important of these in the early days has without doubt been in the field of forestry, but there have been other matters the relevance of which to botany does not appear so obvious, as for example town water supplies and the resettlement of aboriginees. But times and accents change and the present trend is towards nature conservation to protect the little of the natural landscape that is left to us.

Early writers on eighteenth and nineteenth century Malaya emphasised the extensiveness of the forests. In their extensiveness authority saw no need for protection. When the Botanic Gardens were first established in 1859, the Singapore forests had already been so destroyed that Government had on its hands no less than 45,000 acres of abandoned land. (I. H. Burkill, 1918.) That was over a quarter of the Colony. Such reckless destruction had spread to Malacca and Penang and into the Malay States.

Murton, Superintendent of the Botanic Gardens, 1875–80, pointed out in his first annual report (1876) that good timber trees had almost entirely disappeared from Singapore. Government became alarmed at the increasing damage done to the forest of the Straits Settlements and Cantley, who succeeded Murton, 1880–87, was commissioned in 1882 to report on the forests of the three colonies.

* Malaya is used here to mean both Singapore and the Federation of Malaya.

Cantley (1883) recommended the formation of forest reserves as much for the protection of the timber resources they contained as for improvement by re-afforestation with valuable species. In addition he specified the need of proper control over water catchment areas supplying public water services, and for the drafting of reliable maps. It is significant that the world over forestry officers are styled 'conservators'.

In 1884 Government set up a Forest Department under the Botanic Gardens establishment. By 1895 when the Gardens relinquished control of the Forest Department, Cantley and Ridley, who followed him, had secured 88,336 acres of forest reserves in the Straits Settlements. There is no doubt that the official implementation of Cantley's recommendations marked the beginning of a constructive policy of land utilisation and conservation in Malaya.

One of the most besetting obstacles to forest regeneration in Singapore was the frequency of *lalang* fires over the areas adjacent to established reserves or in the pockets within the reserves. Cantley selected *Eugenia grandis* as a fire belt tree. Several of his avenues still exist.

During Cantley's time, the Gardens were concerned with the conservation of water resources. He became adviser to the Malacca and Penang Municipal Councils. Curiously the Gardens had nothing to do with Singapore's supply till very much later.

In the course of his duties with the water supply at Malacca, Cantley had to advise on a land settlement scheme for a part of an aboriginee tribe, the Jakun. This must rightly be considered a conservation of resources, not only because of the water scheme, but because people are a part of a country's resources and because conservation in a wider sense applies equally to a cultural heritage to which undoubtedly the aboriginee tribes of Malaya do contribute.

At a risk of altering the sequence of events, it is convenient here to mention the Gardens' contribution in the post war years to the land utilisation survey which culminated in the drawing up of the Master Plan for the development of Singapore Island. J. W. Ewart, Curator of the Gardens, was as well Agricultural Officer, Singapore, for the period 1948–54 during which time the survey was undertaken. Ewart working in conjunction with R. A. Wright, Singapore's Veterinary Officer, and the officers of the Land Office prepared plans for rural development and the demarcation of agricultural areas. With the creation of many new housing projects a large number of market gardeners were displaced and had to be resettled in the rural areas. These land utilisation plans brought up

many problems, not least of which was the loss of fertility of the upper slopes and tops of hills which had been bare of all but the most impoverished vegetation for decades.

In Singapore the water catchment area of the MacRitchie Reservoir had been extended by 1910 to the land surrounding the Peirce Reservoir. Much of it had previously been alienated for cultivation. The vegetation which returned was an *Adinandra* scrub which is typical of secondary growth on Singapore Island. In 1930 the Governor, Sir Cecil Clementi, saw in this land the makings of a public park. Therein lay a significant widening of the conceptions of conservation by the creation of a public recreational amenity. The Governor instructed that attempts be made to improve the forest and to create bridle paths and to beautify various vistas, which were afforded, with stately trees. The arboricultural work fell to the Botanic Gardens, but it was beset with obstacles and only a little success was achieved before the outbreak of the 1939–45 war stopped this work.

In the 1930's there was a growing public awareness that all was not well with the conservation measures for Malaya's wildlife. A commission of enquiry was established under the chairmanship of T. H. Hubback whose report (1930) advocated measures to protect game within delineated reserves. The Botanic Gardens took no part in this enquiry which confined itself exclusively to animals and Malaya's vegetation was mentioned only insofar as it provided a habitat for wild animals. Singapore itself got but passing reference—that the whole Island should be declared a refuse for most species of birds. The Botanic Gardens however saw the matter in a wider perspective and Holttum advocated to authority that since the F.M.S. enactments protected only animal life but not plant life, the principle that both should be considered together ought to be recognised. Holttum also advocated the reservation of areas containing uncommon plant communities before they were lost for all time under some other form of development. In particular he recommended the protection of Taman Sedia in the Cameron Highlands and Gunong Panti in Johore. After the war Henderson advised in the setting up of Templer Park just north of Kuala Lumpur which has within its limits Bukit Batu Takun (1,387 ft.) a limestone outcrop with its peculiar flora.

In Singapore the Forest Reserves were deleted in 1935 and Holttum and Corner recommended Government to put those at Bukit Timah, Kranji and Pandan, under the Botanic Gardens. In 1939 these areas were reserved again under the Forest Reserves Ordinance and the Director of Gardens, after a lapse of 46 years,

became again the Conservator of Forests. But there was no intention this time of commercial exploitation: it was for absolute protection to provide areas for research, education, recreation and as samples of the country's biographic history and heritage.

These reserves survived the war thanks to the interest of the Japanese Director of Gardens, successively H. Tanakadate and K. Koriba. But in the years after the war the reservation of Bukit Timah came into conflict with granite quarrying interests. Government set up a commission and its reports (Harvey 1950, 1951) recommended the enactment of legislation to put the reserves on a modern footing under a Nature Reserves Ordinance. This recommendation was implemented in 1951. To the three reserves under the control of the Botanic Gardens were added Labrador Cliff, and the Municipal Water Catchment Area.

The intention of the new ordinance was: *"To provide for the dedication and administration of certain lands in the Colony of Singapore as Nature Reserves"*. A Board of Trustees was created with the Director of Gardens *ex-officio* Chairman, and the Board was directed to undertake the propagation, protection and preservation of the indigenous fauna and flora of Singapore and to preserve objects and places of aesthetic, historical and scientific interest. The Board is empowered to provide facilities for study and research.

The reserves when they were created, and still are unique in Malaya. They put Malaya in fact in the forefront of the countries of South-east Asia from the point of providing field research facilities as well as providing educational and recreational amenities so close to the centre of population.

Nature conservation is in itself a development project just as are town planning or the building of aerodromes, roads or railways. But since its stock-in-trade is things which live, as a project it is not amenable to constant change and interference and so it must be considered as a long term one. Allowed to grow on its own it is a complementary anodyne for a modern society in this age of concrete.

This brings the matter up to the present time. The story has had an expanding theme from natural bounty to destruction, through exploitation for commercial benefit to cultural and educational ends. All these stages remain with us in varying degree, but it is to human advantage to eliminate for all time wastefulness. The part played by Botanic Gardens in this endeavour has been fundamental and of great significance in Malaya's development. These achievements have been and will continue to be of the greatest importance for the future.

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The Singapore Botanic Gardens and the Central Institute for Nature Research in Indonesia at Bogor Comments on Past and Present Co-operation and the Need to Continue it

By KUSNOTO SETYODIWIRYO

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THE WELFARE and progress of a country, especially of one with an economy and industry still in its infancy, depend a great deal on its natural resources and on the ability and good sense of its leaders to exploit and to make use of this wealth in such a way as to safeguard the well-being of its people from generation to generation.

The ability to make responsible use of the natural resources rests on a vast and profound knowledge of the soils, the waters, the flora and fauna of the country as well as of its wealth of minerals that are contained in the soils.

A wise and responsible management should be based upon a good understanding of the kind and the potency of the natural resources and of the best way of utilization for the prosperity of the country and the people now and in future.

In view of the welfare and development of a nation the leaders should attempt to know their colleagues in other countries and in the neighbouring states in particular, to create and maintain a mutual understanding, trust, respect and tolerance.

If this basic principle were followed in the field of research, it might become an endeavour to create an atmosphere of international co-operation and goodwill, a sincere spirit of "give and take" with respect to research projects, achievements, views and experiences, exchange of material, and reciprocated visits for research purposes, all for a mutual benefit and improvement. Only on this basis of goodwill and readiness to trust one another can the ideals of international co-operation be truly attained.

The prosperity and achievements of a neighbour state should be greeted with sympathy and rejoicings rather than with a complex of superiority or inferiority which will undoubtedly mar the friendly relations. On the other hand, the misfortunes that befall a neighbour state should be shared, looked into, and relieved as well as possible together as members of a family.

It is in this spirit of friendliness that I wish, on behalf of the Central Institute for Nature Research in Indonesia, to convey our sincere congratulations on the occasion of the centenary anniversary of the Singapore Botanic Gardens. The relations between the Central Institute for Nature Research in Indonesia and the Singapore Botanic Gardens, which has always been characterized by a mutual readiness to help one another, should, or rather needs be continued according to the good, extant tradition, and should even be expanded and intensified in the years to come.

Since the Central Institute for Nature Research in Indonesia, better known by the name of "Botanic Gardens of Indonesia" since its foundation in 1817, has a wider field of activities covering all that lives in nature, both on land and in the waters, this Institute would like to invite the Singapore Botanic Gardens to keep up a more extensive co-operation than the one dealing with the plant world only. I feel that the Singapore Botanic Gardens has a similar function in the State of Singapore as the Central Institute for Nature Research has in the Republic of Indonesia.

The integral task of the Central Institute for Nature Research in Indonesia can be outlined as follows:—

(*a*) To conduct basic research and to give expert training in the field of natural sciences (Botany, Zoology, Ichthyology, Oceanography) under conditions prevailing in tropical areas, for the benefit of practical agriculture, horticulture, landscape architecture, forestry, conservation of nature and natural resources, veterinary science, fisheries and medicine.

(*b*) To collect and to catalogue the plant and animal species occurring in Indonesia and the neighbouring areas, to select scientific names for them and to prepare monographs.

(*c*) To exchange research material, scientific information and publications on the basis of international co-operation.

(*d*) To provide Indonesian and foreign scientists with the accommodation and the facilities to perform research work in the various institutes.

(*e*) To expedite the long-term project of the "Flora Malesiana" Foundation, i.e. to compile a standard work on the vegetation of the Republic of Indonesia and the neighbouring areas on the basis of international co-operation.

(*f*) To protect and care for the natural resources of Indonesia as well as possible and to disseminate knowledge of nature conservation among the general public in accordance with the principles of the International Union for the Protection of Nature and Natural Resources, of which the Botanic Gardens of Indonesia are a member.

(*g*) To maintain a Zoological Museum, a Marine Aquarium, a Freshwater Aquarium, and a Biological Station for Animals Protected by National Laws, for the benefit of popular education.

(*h*) To render advice on the lay-out of parks and gardens, their upkeep and embellishment.

(*i*) To build up a Central Library for the Natural Sciences and to supply books and periodicals needed by the different institutes of the Ministry of Agriculture.

(*j*) To carry out orders from the various institutes for making scientific pictures, films and drawings, and to train candidates in scientific photography and drawing.

The above mentioned task is carried out concordantly by the following institutes of the Central Institute for Nature Research:—

1. Hortus Botanicus, founded on 18th May, 1817.
2. Herbarium Bogoriense, founded in 1817.
3. Flora Malesiana Foundation, founded on 21st October, 1950.
4. Treub Laboratory, founded in 1884.
5. Institute for Microbiology, founded in 1956.
6. Museum Zoologicum Bogoriense, founded in 1894.
7. Institute for the Conservation of Nature, founded in 1937.
8. Biological Station for Animals Protected by National Laws, founded on 17th August, 1957.
9. Institute and Aquarium for Marine Research, founded in 1904.
10. Bibliotheca Bogoriensis, founded in 1842.
11. Photographic and Drawing Studios, founded in 1878.

All of which form one harmonious and inseparable unit.

The Importance of Tropical Taxonomy to Modern Botany

By E. J. H. CORNER

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EFFORTS TO LEARN about plants are called botany, when they are sufficiently rational. Efforts to grow plants and make new ones and to destroy the harmful and unwanted are parts of agriculture and sylviculture, when they are sufficiently profitable. Our enjoyment of plants, wild or in the garden, has no name, but it is an aspect of civilisation as essential as art and literature; and horticulture is a sign of progress. Thus, in concourses of men, the academic, the applied, and the recreational sides of plant-lore have developed into the botany schools of universities, the plant-breeding stations of agriculture, the research institutes of forestry, the nature-reserves of wild-life services, the parks and botanical gardens of cities, and the flower-beds, window-boxes, vases, and books of the home. Wretchedly barren is that community unmindful. In this concrete age, which hardens our lives, we should reflect upon the appeal of kampong, sawa, pasir panjang, gunong hijau, sungei berassau, and kayu chondong. The beauty of Rio de Janeiro, so inspiring to the visitor, is the city in the bay of forested mountains. Seeing then that botany, if we use that word for all ways in which plants enter our lives, is a subject vital to learning, practice, and recreation, let us consider the harder word taxonomy.

Taxonomy. All sciences split up as particular methods are used in their study. Botany, too, is sundered into an increasing number of "-ologies", many of which require not a knowledge of plants so much as of other natural sciences, and an electron-microscopist or radiographer may be a botanist. One of these divisions is now called taxonomy. It is the old core of professional botany, derived from the herbalists through the systematists who variously improved the classification of plants. It is regarded as old fashioned, being the parent, but rather is it the trunk to the branches, ever swelling as they multiply, gathering the information, and, I believe, still the core and heart of botany. Several "-ologies" and "ographies" are indeed, attributed to taxonomy, which means the method of orderly classification but we can understand better what it is from its outcome. Nowadays taxonomy is the classification of plants according to their evolution. The early botanists and zoologists

discovered that plants and animals were constructed in definite ways, from which an orderly classification could be thought out and named, so as to give a better and international understanding of biology. A good classification is needed in science to pigeon-hole the enormous and ever-increasing number of facts: that it is objective and satisfactory, international recognition proves. Until a hundred years ago, however, this classification was an enigma because there was no adequate explanation of the expanding, varying, and yet coherent, marvellous pattern of life which it revealed, or why it should have been satisfactory. Darwin's theory of evolution was not a flash in scholastic darkness, but the sun which rose on biology. The orderliness of classification was seen to express the evolution (and extinction) of plants and animals in the past. They were being classified on the peculiarities of their various lines of descent, or heritages; being founded on "raison d'être", this was the order so satisfactory. The sun, I think, was the spontaneous combustion of taxonomy, but that is another story. To appreciate the importance of taxonomy, as evolutionary classification, we must consider a method of scientific enquiry which it has introduced. This is the distinction between homology and analogy. The method is most useful in other branches of biology which have not been able, because of the baffling complexity of protoplasm, to advance as far as morphology, or the study of structure, on which taxonomy is based. I refer particularly to physiology, genetics, biochemistry, and other experimental subjects which are incapable of classifying living things, of correlating the facts of biology, and of organising biological thought.

Homology and Analogy. There are two ways of studying plants and animals, namely the particular and the comparative. In the particular we investigate one kind of plant or animal, or one part of it, intensively. Thus, we may study the respiration of a root or muscle, or the absorption of mineral salts by root hairs, or the inheritance of certain characters such as flowering-time, grain-size, or seed-production in a plant such as the rice-plant. As any of these subjects, or the means by which they are studied, can be developed into a particular branch of science, it can be seen how these branches multiply in modern research. Sooner or later comparison must be made with other plants or animals, but what ones? Obviously comparison of objects superficially similar, as fish and whales, or ferns and palms, may be exceedingly misleading, for their similarities are analogous, not fundamental; and, as we are dealing with the minute and intricate behaviour of this exceedingly complex, largely unknown, protoplasm of living things, we must avoid as

many unknown quantities as possible. The best comparison, therefore, will be between species which have been shown by modern taxonomy to be closely allied: their protoplasm will differ the least from each other and these slight differences may be exactly what the researcher needs. Basically, plants have a certain and not impossibly large number of properties, or things which they can do. Respiration, photosynthesis, cell-differentiation, and reproduction, for instance, are essentially the same in all green plants, but the species differ in the way in which these processes are variously amplified, side-tracked, baffled, distorted, suppressed, and so on. This baffling of living processes, as we may call it, occurs largely through the solid parts of the plants making up their visible structure, on which morphology, and so taxonomy, are built. Now any one living process consists of many steps. One species of plant may have steps A—D, another A—H: one may exaggerate B—D at the expense of A and E, or *vice-versa:* another may add N—Z, and another eliminate A—P: some steps may be passed over so rapidly as not to be detectable, and so on in endless variation. Thus, when we study one plant in particular, we cannot know how the process under investigation is baffled: probably we have only part of the picture, and we do not know which part. To understand more fully we must compare taxonomically related species (of the same general heritage) which will, through the very fact that they are not the same species (or genus) and have not precisely the same protoplasm, reveal other parts of the picture. This is homologous comparison as distinct from the artificial and analogous comparison which will introduce a multitude of unknown quantities; and homologous comparison depends on good taxonomy: it is, in fact, taxonomy. Obvious and simple as this important method of enquiry seems, it is far from being generally appreciated, and a great deal of botany is confused by analogous comparison. Nevertheless, it is being tacitly adopted because it works, and it is my purpose in this article to make sure that we understand why it works. Thus, comparative cytology, dealing with chromosome-numbers, structure, and behaviour, could never have been developed if there had not been the taxonomic work for it to follow: the tendency is to extol the new cytology and forget, if not to ridicule, the service of taxonomy. Laboratories have begun to look for new "guinea-pigs": hitherto they have adopted what was at hand, but they should be advised to enlarge their stock-in-trade taxonomically. Plant-breeding is scouring the world for wild species allied to crop-plants, whereby to breed new strains. Sylviculture is considering other timbers as world-demand exhausts supply. Horticulture is experimenting with the vigour and novelty of hybrids. In every case the

Flora Malesiana and similar works on Africa in process of publication. But, for the taxonomic progress with living plants and all the impetus to botany, theoretical and applied, which will follow, we must look to the botanical institutes in tropical countries. I am impressed by the growing number of young students in the tropics. The thirst for knowledge cannot be quenched. They will build, and civilisation will expect it. Western science has led the way to a better appreciation of nature, but the tropical countries must now help their eager students to extend this knowledge in their own rich heritage for the benefit of mankind. I have often thought that what has been started in botany in Europe and North America will eventually have its headquarters in the tropics where the plants themselves orientate thought. On the tropical students now falls the responsibility for writing their biological floras, as is the newest taxonomic development in Europe. Theirs will be the responsibility of preserving the native vegetation and the beauty of the country by wayside and in national park, and of collecting the living assemblage of economic, ornamental, and rare plants for research and recreation in botanic gardens. Theirs will be the opportunity to step up all botany by study of new sorts of protoplasm. It is a hopeful glimpse. At present they may lean on outside support, but I look to the time when students from outside will learn in the tropical institutes.

In conclusion, tropical countries have a duty to promote botany. They inherit a rich share of plant-evolution, which has yet to be incorporated into the wisdom, practice, and enjoyment of civilisation. Their students will expect intellectual progress. In practice, success will depend on taxonomic efficiency, which is the chief scientific work of botanic gardens; other subjects will be developed by universities, special institutes, and amateur societies. It is not a pole or bush to be grown, but a tree of knowledge, the trunk whereof is taxonomy.

The International Code of Nomenclature for Cultivated Plants with Special Reference to Tropical Botanic Gardens

By J. S. L. GILMOUR, M.A., F.L.S., V.M.H.

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THE NAMES OF PLANTS are of three kinds, botanical or scientific names (e.g. *Mangifera indica*), common or vernacular names (e.g. Mango), and the names of the cultivated varieties or cultivars (e.g. the Mango 'Jaffna'). The use of botanical names is governed by *The International Code of Botanical Nomenclature,* under the control of successive International Botanical Congresses; common names are gloriously free from all control, except that of common usage; cultivar names of horticultural plants have for many years been, in theory, subject to an International Code, but, until recently, the Code was virtually unknown to most horticulturists, and it is only since 1953 that a widely circulated Code has been available to those concerned with cultivated plants. It is this Code that I want to discuss in this article, and especially its importance to the naming of plants cultivated in the tropics.

The *International Code of Nomenclature for Cultivated Plants,* published in 1953, was really a combined effort of the International Botanical Congress held at Stockholm in 1950 and the International Horticultural Congress held in London in 1952. Though entitled "for Cultivated Plants", it was drawn up primarily with *horticultural* plants in mind, and it soon became clear that several modifications would have to be made if it was to be equally serviceable to agriculturists and foresters. Accordingly, a special *International Commission for the Nomenclature of Cultivated Plants* was established under the International Union of Biological Sciences, and this Commission set to work to re-formulate the Code so that it would apply satisfactorily to *all* cultivated plants. The full history of the work of the Commission is set out in the Preface to the new (1958) edition of the Code that it produced, together with the names of the agriculturists, horticulturists, foresters and botanists responsible.

The Code is obtainable from the Royal Horticultural Society in London and, since its publication, is gradually becoming known

the registration of names of cultivars of ornamental and useful genera grown in the tropics. This is where tropical botanic gardens might play a very useful role, especially in acting as registration authorities for ornamental genera. An increasing number of cultivars are being produced in these genera and it is important to begin registering their names, and printing basic lists, at as early a stage as possible, so as to prevent the development of overlapping and duplication. *Bougainvillea, Hibiscus, Nerium,* and *Zinnia* are genera that spring to mind, and there are, of course, many others, both ornamental and useful, that should be included in a comprehensive scheme. It should be emphasised that, although it is highly desirable to combine cultivar trials with registration, this is not essential, and the registration of names can be carried out independently of such trials. If any botanic garden or other suitable institution in the tropics feel that they are able and willing to act as a registration authority, they should communicate with the Secretary of the International Commission, Dr. H. R. Fletcher, The Royal Botanic Garden, Edinburgh.

I hope that this very brief account of the International Code and of the registration scheme that it embodies will be of interest to those concerned with the cultivars of tropical plants, and that they will promote international co-operation in this important field by following the provisions of the Code and by helping to set up registration authorities where they are needed.

The Importance of Biological Research in the Pacific Region

By F. R. Fosberg

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The Pacific Science Association

At first glance The Importance of Biological Research in the Pacific Region seems such an obvious topic that anything one might write about it would be a truism. The world, including the Pacific, is dependent for its food supply on the products of several branches of applied biology. Large parts of industry depend for raw materials on applied biology. We all depend for cures for our ills and injuries on applied biology.

Before going on it may be well to define our terms. Biology is the field of science that deals with living things. Its scope runs from minute bacteria and even viruses to flowering plants and from the simplest one-celled animals to dinosaurs, elephants and man himself. It deals not only with the kinds, nature and physiology of organisms, but with their relationships to each other and to their non-living environments. Research is the attempt to learn new facts and to determine their significance in relation to what is already known. It is biological research, of course, when the facts learned are about living things.

Hence, agriculture, husbandry, fisheries, forestry, and medicine are branches of applied biology, and are only some of the branches that affect our daily lives. And biological research is the search for new knowledge bearing on these vital activities. Who could question the importance of this? In view of the facts that we do not have enough food for all the people, that raw materials are often scarce, that we still fall ill and die before our normal life span is over, it would seem obvious that biological research would be regarded as perhaps the most important of all activities, that the demand for it would be unlimited and the amount of research would only be limited by the supply of competent and willing research workers.

Curiously enough, this is not generally the case. What we know about agriculture, forestry, fisheries and other applied fields in biology is taken for granted. The research worker is commonly regarded as a strange man, perhaps a little mad. That there should be a reason to pay him a salary, or that he should need funds for his work, are hard for the politician who controls the spending of

public money to understand and harder for him to accept. And when the budget must be reduced, the first and easiest item to cut out is research. This may seem incredible and incomprehensible but is a phenomenon observed repeatedly. It may be worthwhile to seek an explanation for it.

Clearly basic to the problem must be a lack of awareness that all is not going as well as it could. The politicians and the influential people that control them are not the hungry ones. Their economic situation is such that they can buy food when they need it regardless of its scarcity. If they are users of raw materials, scarcities only show up, during peace-time, at least, as increases in costs which are simply passed on to the consumer in the form of increased prices. Deficiencies in medical knowledge, indeed, do become evident to even the most comfortably situated and influential politician or magnate, at least when he gets old. And it is significant that medical research is by far the best supported of the research activities of biology.

Perhaps the best way to approach the subject of the importance of biological research is to examine the general system in which we live, to see just what troubles that result from an insufficiency of biological knowledge might be corrected by research. If attention can be directed to these and some indication given of how biological research is pertinent toward remedying them the general question may be clarified.

The fact that people are inadequately nourished was mentioned above. It has been said that this is due to inadequate distribution rather than under-production. However, if distribution of food were really equalized, probably the well-fed among us would gain a slight knowledge of the pangs of hunger and the presently hungry would only be a little less so. And with this somewhat more adequate nourishment more of the presently starving would survive, susceptibility to disease would be less, and population would increase to where the food supply would be on the whole more inadequate than now. Research in agriculture, and in the various basic aspects of biology that are applied by agriculture, can contribute greatly toward the alleviation of current food shortages, also of shortages of raw materials produced by agriculture. Few in Malaya will have to be told of the part played by botanical research in the present prosperity of the area. The entire rubber industry in Malaya stems from the experimental introduction of the *Hevea* rubber tree into the Singapore Botanic Gardens where it was nurtured by the botanist Ridley. Research has been the constant accompaniment of every step in the development of this industry from the stage of gathering gum from the wild trees in Amazonia to the

highly efficient plantation culture in modern Malaya. One hundred fifty years ago *Hevea* was only a botanical curiosity. Palm oil, cane sugar, quinine, and pineapples are only a few of the plantation crops that are produced in a very efficient and economical manner today because of large investments in biological research.

Although medical research has changed the lives of people in the tropics from continual struggles with a host of parasites no one would pretend that we have reached the point where long healthy lives are to be assumed as normal. Tropical medicine and public health are more than ordinarily dependent on basic biological research because they lack the long background of research possessed by temperate medicine. We do not even know the complete ecology and life history of some of our serious parasites and disease vectors.

A few years ago there was a fairly widespread idea that synthetic chemistry had pretty well taken over the drug field—that plant products were interesting only as examples of primitive medicine, not to be compared with sulpha and other synthetic miracle drugs. Then came penicillin, cortisone, and reserpine and a sudden intensive preoccupation arose with a large number of obscure plants, from microscopic bacteria and fungi to forest trees. These plants occur in all parts of the world, but the tropical Pacific has more than a small share of them, because of the enormous flora of this tropical region. Research on medicinal plants is slow tedious work, and much of it never pays off, but the occasional important discovery much more than justifies the entire outlay in work and money. This is, of course, much more apparent to the sick man than to the healthy one. Few people who have been cured of pneumonia by antibiotics would doubt the wisdom of money spent on pharmaceutical microbiology.

One of the serious difficulties in tropical countries is the degradation of the soils. Originally it is probable that most tropical soils were in a state of equilibrium with the biological communities that occupied them. When man came into the picture this equilibrium tended to become more and more disturbed. As man's ability to affect this environment increased, through his development of implements and technology, his numbers grew. More strain was put on his environment as more demands arose for its productions. One only needs to look at the waste places on Singapore Island to see in aggravated form the results of this pressure on the resources of the soil. Degraded vegetation and exposed subsoil, capable of producing almost nothing of value are almost the rule here as in many thickly populated tropical areas. Although great steps have been made in preventing and alleviating such conditions in the temperate zone little has been done in this direction in the tropics.

This is primarily a biological problem, one of managing vegetation and soil biota, of working out wiser methods of using the soil, and more importantly, of managing or slowing down the growth of human populations. Intensive research in the biological fields basic to all of these activities is urgently needed, especially as environmental failure is cumulative.

A specter haunting agriculture, forestry, and all activities depending on plants is plant disease. Crop losses and landscape degradation from plant disease reach enormous proportions. In temperate areas vast amounts of research in plant pathology are required just to keep pace with the increasing ravages of plant diseases. In the tropics there are, at present, more diseases and less research. And as agriculture and forestry become more intensive, disease problems increase, rather than decrease. Monocultures provide ideal conditions for the spread of diseases. New strains of disease organisms come into existence and become established. The same can be said of insect pests. At the present level of research in plant pathology and entomology we can not hope to hold our own, especially in the tropics.

So far the discussion has concerned only areas where serious difficulties are to be corrected or averted. Examples of these could be multiplied indefinitely, especially by going more into particular cases. Of importance, also, are areas where improvements in already tolerable existing conditions may be brought about by research. We have palatable fruits and other food crops in our gardens and fields. This does not say, however, that they are the best possible. Plant breeding has in the past made the difference between the inferior, often almost inedible wild products, and the fine domestic varieties that we have. This was accomplished without much knowledge of the principles underlying the evolution of new kinds of plants. Now the science of genetics is an advanced discipline and future possibilities in plant breeding dwarf completely past accomplishments. In the past necessity guided the groping plant breeder. Now, knowledge of the possibilities should provide the stimulus and imagination can furnish the direction. The same can be said of breeding of other classes of economic plants and animals.

The ways in which man's environment can be influenced to make it more agreeable for him to live in are countless, and many of them depend on biological research. Most of them, unfortunately, will take the form of counteracting detrimental changes brought about by man's own activities. Man was well adapted to his primitive habitat. As he has changed this environment it has in many respects become more unsuitable for his occupancy. This does not

seem to be necessary but it has happened and is continuing in accelerated fashion. The advice of ecologists is vital to retarding or reversing this trend. This advice must be based on extensive research, most of which has not yet been done. If man is not to foul his nest so completely that it will eventually be uninhabitable he must understand his own relation to his environment. This will come about by properly oriented ecological research.

So far this discussion has been devoted strictly to matters that affect man's material needs, comfort, and well-being. These are important, but there is all too great a tendency to consider them to the exclusion of everything else. Traditionally, the peoples of tropical Asia have been able to strike a better balance between the material and the higher aspects of life than most others. With the impact of Western culture there is a tendency for the material side to receive more emphasis. This is not necessarily good. It entails a loss in some of the virtues inherent in some Asiatic cultures. Though science is generally thought of as strictly a materially oriented activity it is fortunately not completely so, either in its motivations or in the benefits it yields. One or two of the other facets may be examined to give us a truer picture of the place and importance of biological research in the present phase of the cultural history of the tropical Pacific region.

The greater part of the people of this part of the world belong to newly independent nations, after varying periods of colonialism. During the colonial period the cultural patterns changed, here as indeed in western Europe, from a mediaeval, essentially feudal state, more or less self-contained and in equilibrium with local environments, to modern membership in a highly integrated world community, completely dependent on the application of scientific knowledge and accomplishment for its normal functioning. A heroic, if somewhat frantic, effort is being made by these peoples to participate in the material and social benefits of modern scientific achievement and technology. This is regarded as an inherent right. Most of the science at present emanates from the western world, much of it from former (and present) colonial powers. The question has been asked if the newly independent peoples are really ready for full participation in the modern scientific world community, whether an essentially parasitic status, scientifically, is proper or justified. The question has even been asked whether the members of these non-western cultures are capable of scientific achievement equal to that of their western colleagues.

On the basis of actual quantity and quality of work done in these countries at the present time there is a certain amount of valid reason for these questions. Rather little work is done and much of

it does not measure up to the best produced elsewhere. However, those of us with experience in these countries and with personal acquaintance with indigenous scientists there mostly realize that present inferiority in output results from the cultural situation rather than from any inherent lack of ability among the scientists. In cultures where in the past there have been few opportunities for scientific work among the local people, poor educational facilities for them, and no scientific tradition, there is not likely to be immediate superior scientific accomplishment. If the intellectual climate is not right for it, and if no prestige is attached to it, science will not flourish. At the present time in southern Asian countries there are few scientists and these are smothered by administrative duties. This is especially true of biologists. It is obviously of the utmost importance to correct this situation, and clearly the way to do it is to emphasize, in every way possible, officially and privately, the importance of biological research. It is clearly essential to show the world that countries newly emerged from a dependent status are capable, both of attracting first-class foreign scientists and of eventually training local scientists who are the equals of those in other countries. This is to be done, obviously, not by creating scientists by official decree, but by placing such emphasis on research that young people with high intelligence and with scientific inclinations will be attracted into scientific careers and will realize the necessity of achieving training and standards equivalent to those prevalent abroad. This is a long-term project and crash programmes are not the answer. Rather, steady emphasis on research and well-directed support for it will bring about sound progress.

Finally, it must be pointed out that, important as are the practical, economic, and political benefits of biological and other scientific research, the fundamental importance of this, as well as other intellectual activities, lies in the development of the human mind and in the satisfaction of man's curiosity and his desire to understand his universe and his place in it. This is the motivation for all research beyond the solution of obvious immediate practical problems. The place of pure research as an intellectual activity and the strength of the urge toward understanding in a culture is perhaps the best measure of its degree of advancement in the scale of civilization.

Role of Botanical Gardens in the Humid Tropics and UNESCO's Programme related to them

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LUXURIANT VEGETATION is a prominent feature of the humid tropical regions and yet very little of it is known. The nature of the plants making up this vegetation, methods of propagation, growth requirements, potential use for the benefit of man—timber, products, barks—have not been studied systematically so far. This handicaps planning and development of agriculture and forestry, important contributors to the economy of a tropical country.

The little information available at present has chiefly come from botanic gardens maintained by departments of agriculture or scientific societies. There are at present only a small number of botanical gardens in the tropical regions. Some of them are:

— Botanic Gardens, Peradeniya, Ceylon
— Central National Botanic Garden, Calcutta
— National Botanic Gardens, Lucknow
— Botanic Gardens, Singapore
— Jardim botanico do Rio de Janeiro
— Botanic Gardens, George Town, British Guiana
— Royal Botanic Gardens, Hope, Kingston, Jamaica
— Botanic Gardens, Bogor, Indonesia.

The gardens are of different size and their activities include maintenance of a representative collection of the vegetation of a region, demonstration of principles of conservation of vegetation, maintenance of nurseries of plants, collection, preservation and exchange of dried plant specimens for purposes of identification. It is commonly acknowledged that much of the natural vegetation of the humid tropical regions is cut down or burnt unmethodically resulting in erosion of the soil and this results in subsequent damage by floods. The botanic gardens—the large ones with extensive enclosures—have a definite role here to play in demonstrating to the general public the useful role of vegetation in binding soil, thus preventing erosion and making them useful for agriculture. It may be added here that in the desert tropical regions,

where the advance of sand dunes threatens valuable agricultural land, demonstration of fixing the sand dunes by appropriate vegetation is a definite function of a botanical garden located in a desert tropical region.

Secondly the gardens can play a valuable role in breeding plants resistant to various types of plant diseases in nurseries and trial plots and then distributing such varieties to agriculturists. It can and does help in introducing plants which thrive in similar environments in another region to its nursery for the first time and breeding one or more generations of them, thus making them adapted to their new surroundings. Further some plants are in danger of complete extinction from the surface of the earth owing to their inability to adapt to possible changes in the environments in which they grow. It would be valuable to protect them and to increase their numbers if possible, and the botanical gardens can play a vital role in this matter. Several botanic gardens undertake such projects and examples that come to the mind are the Medicinal Garden in Ganewatte in Ceylon, the Botanic Gardens of Hakgala and Gampahe, the Botanic Gardens in George Town, British Guiana, the Royal Botanic Gardens, Hope, Kingston, Jamaica.

Most of the botanic gardens maintain a herbarium wherein type specimens of plants are preserved for taxonomic studies. This material is annotated by competent botanists describing their chief characteristics, places from where they have been collected and their scientific names. In order to do this regular expeditions are undertaken to different areas to collect the plants. Several sets per species are collected and the specimens are suitably mounted on sheets of paper to preserve them. Identified duplicates of the specimens are exchanged with herbaria in other parts of the world. Preparation of floras of the region are undertaken utilizing the material preserved in such herbaria. The preparation of the flora of the Malaysian region is currently in progress and a large number of herbaria and taxonomists all over the world are co-operating in the project.

The humid tropics programme of UNESCO intends supporting the collection, identification, preservation and exchange of material in herbaria. Until now, material collected had to be sent abroad for identification purposes. This has naturally retarded the regular publication of the floras of tropical regions, important in knowing the features of the vegetation in the regions.

The first step is the organization of regular expeditions for collection purposes from a large number of selected institutions located in the humid tropical regions. In order to do so, a number of specialists have to be trained to undertake regular expeditions.

Relatively well-established institutions in the tropics would serve as key centres for organizing training programmes. UNESCO assistance would be utilized to finance this training programme, by provision of foreign specialists, equipment, etc. It would also bear the costs of publication of results.

UNESCO's Advisory Committee for Humid Tropics Research at its first session in Manaus (Brasil) in July 1957, recommended that the Secretariat study the practicability of establishing such key herbaria. Information from a large number of herbaria in the humid tropical regions was collected regarding the nature and total number of specimens, annual additions, sources of specimens, identifications carried out and exchange of specimens effected during the last three years. More than 100 institutions furnished this information, and it is hoped that a short list of suitable institutions for development as key herbaria will be established by the Advisory Committee.

Depending on the finances available, it is hoped to conclude agreements with these institutions to make arrangements for organizing training programmes.

Another form of UNESCO's activities in the field of Humid Tropics research in which we collaborate closely with the botanic gardens, is the convening of scientific symposia under the auspices of this UNESCO Office, e.g. the Symposium on the Study of Tropical Vegetation in Kandy, Ceylon, in March 1956, which was organized jointly by this UNESCO Office and its sister office in New Delhi; the Symposium on the Phytochemistry of Tropical Plants in Kuala Lumpur, Malaya, in December 1957, and the Symposium on the Vegetation of the Humid Tropics, held in Bogor, Indonesia, in December 1958.

It may also be mentioned that this UNESCO Office has on several occasions awarded grants to facilitate the exchange of research workers between botanical gardens and herbaria in the tropical regions.

It will be evident from the foregoing that UNESCO is deeply concerned with the development of botanic gardens. Their collaboration is indispensable for the implementation of the UNESCO programme in Humid Tropics research. The UNESCO Science Co-operation Office for South-east Asia is happy to express its appreciation of the scientific work done by the Singapore Botanic Gardens. We congratulate the Gardens on the Centenary and express our hope for fruitful collaboration in the future.

Regenerating High Forest on Singapore Island

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Introduction

Notes on secondary or subseral vegetation on Singapore Island were given in a previous paper (Gilliland, 1958). Most of the island is covered with such vegetation today and the causes of this are made patent from the history of gambier, pepper and coffee cultivation and timber and fire-wood exploitation as recorded by Burkill (1935, p. 2201). The principal surviving relic of primary high forest has long been preserved first as a forest reserve by the Forest Department of the Straits Settlements, and later as a nature reserve by the Nature Reserves Board, Singapore. This relic of some 152 acres covers the upper slopes of the island's highest hill, Bukit Timah, and is the type-locality for a remarkably large number of species. The possibility of the existence elsewhere on the island of small relics of primary high forest was made manifest from a study of aerial photographs. A large area jointly maintained as a Nature Reserve by the City Council and the Nature Reserves Board comprises the catchment area of the three principal reservoirs of the City's water supply. The southernmost of these is the MacRitchie Reservoir and the photographs suggested that the vegetation along its southern shore would warrant study. Such study reveals the presence of a forest of Dipterocarp dominated type which has not been so exploited as to alter radically its character. This paper discusses the results of the application of a line transect sampling technique to this forest.

History

Enquiry from the City Water Engineer reveals that this Reservoir first came under the control of the City Council Water Department in 1857.

The Office of the Commissioner of Lands, Singapore, records that in the same year the piece of land on which this forest now stands was granted to Mr. Sim Wye Tye (Indenture No. 19) and Mr. Tan Ah Pok (Indenture No. 84).

Further sales of this land, of the first portion in 1876 and of the second portion in 1858, to further owners are recorded but in 1890 the Municipal Commissioners acquired all the land in this area. The acquired land was surrendered to Government and on

2nd June, 1906 was re-issued with new title to the Municipal Commissioners.

In 1910 the bridle path, which currently traverses the forest from west to east, was cut and in 1933 the road "Lornie Road" which, today, forms the southern boundary of "MacRitchie Reservoir Jungle" was constructed.

It is reasonable to conclude, especially in light of the more recent building of the paths and roads, that such occupation of the land as did occur was not wholly destructive of the then-existing vegetation. However, the existence of an old road crossing the reservoir from north to south, recently revealed during a drought period, indicates that communications, even if of different pattern from the present, did exist previously.

Principal Trees

There are many large trees in the area and specimens of the following with a diameter at breast height, or above buttress, of 2 feet or more (76 in. girth) were noted.

1. Adina rubescens
2. Alstonia angustifolia
3. Anisoptera megistocarpa
4. Aquilaria malaccensis
5. Artocarpus scortechinii
6. Artocarpus lanceifolius
7. Artocarpus anisophylla
8. Artocarpus rigidus
9. Calophyllum floribunda
10. Campnosperma auriculata
11. Castanopsis hullettii
12. Cinnamomum iners
13. Cryptocarya griffithiana
14. Dipterocarpus hasseltii
15. Dipterocarpus apterus
16. Dipterocarpus kunstleri
17. Dyera costulata
18. Dysoxylum mollissimum
19. Fagraea fragrans
20. Ficus consociata v. murtonii
21. Gordonia singaporeana
22. Heritiera simplicifolia
23. Irvingia malayana
24. Koompassia malaccensis
25. Melanorrhoea woodsiana
26. Nephelium lappaceum
27. Palaquium rostratum
28. Palaquium obovatum
29. Pygeum polystachyum
30. Quercus brevistyla
31. Santiria laevigata
32. Santiria tomentosa
33. Santiria griffithii
34. Shorea ovalis
35. Shorea glauca
36. Shorea paucifolia
37. Vitex pubescens

It seems reasonable to conclude on the basis of such mean annual increment data as are available (Edwards, 1930) that none of these trees is likely to be older than 100 years. This finding agrees with the supposition that following the original alienation of the land little more than the extraction of standing timber was done—the present trees would then represent the successful subsequent growth of existing regeneration (Richards, 1952).

Sampling Method

To contrast this with the secondary forest already examined (Gilliland, 1958) it was decided to make a similar line transect

sample. The sample consists of a belt or transect 1,000 feet long and 6 feet wide and is obtained as follows:—

(*a*) It is divided into 10 sub-samples each 100 feet long, each sub-sample taken at random.

(*b*) Each sub-sample is obtained by laying down a surveyor's 100 foot chain. Thereupon the No. 1 of the pair of observers prepares four 3 feet wands which are spaced and respaced along the chain to demarcate convenient portions 6 feet wide. No. 2 of the pair of observers acts as amanuensis recording data, and the team works its way along the chain.

(*c*) All woody stems are measured with a diameter tape so that they may be recorded in the size categories 0–1; 1–3; 3–5; 5–7; and $>$ 7 inches.

(*d*) A specimen of any seedling, sapling, or tree which cannot immediately be identified is numbered and collected for identification.

It is wise to make two practice 100 foot samples before commencing on the serious record in order to become familiar with the principal plants present in all their stages.

A sub-sample takes between 1 and 2 hours to record in the field. As soon as the data for a particular sub-sample have been obtained work on the "unknowns" begins. This may occupy a further week. Not till this is complete does work on the second sub-sample begin. Identification was greatly assisted by the knowledge and help of 'Che Ahmad bin Hassan and Tuan Haji Mohammed Nor bin Mohd. Ghous both of whom had served on the Botanic Gardens staff for over 40 years. Much time and patience is clearly required to complete a sample.

As noted above 10 sub-samples were used for the collection of the data. The question then arose as to whether or not one can generalise from the 10 sub-samples and draw conclusions about the total area from which the sub-samples were taken.

The first step was to determine whether or not these 10 sub-samples could be treated as a random group of samples from the general area. The intention was to test this by the *analysis of variance* technique. One of the requirements of the analysis of variance technique is that the variability should be similar from one sub-sample to the next. Putting it another way the 10 sub-samples should be homogenous with respect to the variability of the frequencies. This test for homogeneity was carried out by means of Bartlett's test and the samples proved *not* to be homogeneous by this test. The results are presented in table I.

TABLE I

MEANS AND VARIANCES OF THE FREQUENCIES OF THE 205 SPECIES IN THE 10 SUB-SAMPLES.

Sub-sample No.	*Mean Frequency*	*Variance of Frequencies*
	1.33	21.90
	1.53	19.45
3	2.43	52.98
4	2.42	41.70
5	2.63	79.87
6	2.74	49.16
7	2.80	67.40
8	2.05	30.81
9	1.82	17.86
10	2.43	44.10

Bartlett's Test: $X^2 = 236.64$
$P < .001$

The result of Bartlett's test therefore made the application of the analysis of variance "F—test" questionable. The decision was made then to test all the possible differences between the means of the sub-samples by the "t"—test of significance. Forty-five t-tests then had to be carried out. With the 0·05 level of significance as the critical value, if the hypothesis of random sampling is tenable, there should be no more than 3 differences large enough to be judged significant at the 0·05 level and beyond. When the 45 tests of significance were carried out 3 differences barely reached the ·05 level of significance. These differences were between sub-sample 1 and sub-sample 6, sub-sample 1 and sub-sample 7, and between sub-sample 2 and sub-sample 6. No difference reached the 0·01 level. Thus with respect to the means of the 10 sub-samples one can retain the hypothesis that they are random samples from the same population.

It is interesting to note that in spite of the violation of the homogeneity of variance test and in spite of the distributions being non-normal the overall F-test shown in table II clearly supports the conclusion above that the means can be assumed to be drawn from the same population.

TABLE II

ANALYSIS OF VARIANCE TEST OF RANDOM SAMPLING.

	Sums of Squares	*d.f*	*Variance Estimate*
Between sub-samples ..	485.95	9	53.99
Within sub-samples ..	86,742.58	2,040	42.52

$F = 1.27$
$P > .05$

The data were then rearranged from the index cards and each of the 205 species was classified according to its "B" (belongingness) value where the value of "B" is the number of sub-samples in which that species occurred; thus "B" = 7 means the species has been recorded in 7 out of 10 sub-samples and "B" = 2 means the species has been found in 2 sub-samples only. A "B" value was determined for each species.

It is clear from the above definition of "B" that one would expect a positive correlation between the frequency of a plant and its "B" value, but there is no reason to expect this relationship either to be linear or perfect. Table III shows the scatter diagram of the two-way plot of "B" values and frequencies. The positive relationship and its non-linearity can readily be seen from the table.

TABLE III

SCATTER DIAGRAM OF "B" VALUES AND *FREQUENCIES*.

"frequencies"	"B" values									
	1	2	3	4	5	6	7	8	9	10
200–299	..	..	..	..	..	..	..	..	.	2
180–199	..	..	..	..	..	..	..	..	2	..
160–179	..	..	..	..	..	..	2	..	..	1
140–159	..	..	..	..	..	..	2	..	1	..
120–139	..	..	..	..	..	..	..	1	..	1
100–119	..	..	..	..	..	..	..	..	..	3
90–99	..	..	..	..	..	..	..	..	..	1
80–89	..	..	..	..	..	..	..	..	..	2
70–79	..	..	..	..	..	..	1	..	..	..
60–69	..	..	..	..	..	..	1	..	..	..
50–59	..	..	..	..	1	.	1	..	1	1
40–49	..	..	..	..	..	2	2	1	..	..
35–39	..	..	..	..	..	1	1	1	1	..
30–34	..	..	.	..	..	.	.	..	..	..
25–29	..	..	1	..	..	2	1	3	1	..
20–24	..	..	.	.	4	3	2	.	..	..
15–19	..	..	1	2	2	1	3	2	..	..
10–14	..	..	.	3	4	4	2	1	..	..
9	..	..	1	2	.	.	..	..	..	..
8	..	..	..	1	1	1	1	..	..	..
7	..	..	..	.	3	..	..	..	..	..
6	..	..	.	2	1	..	..	..	..	..
5	..	..	3	3	..	..	..	..	..	..
4	..	1	2	4	..	..	..	..	..	..
3	..	2	2	7	..	..	..	..	..	..
2	..	14	13	..	..	..	..	..	..	..
1	..	58	.	.	.	.	..	..	..	..
Tota's	..	75	23	25	7	16	14	19	9	6	11

(*Note:*—The grouping interval of the *frequency* variable has not been kept constant in order to show the non-linearity more clearly).

A priori considerations had led to the tentative conclusion that plants having a "B" value of 7 and higher were more likely to "belong" to that particular area than those with "B" values of 6 and lower. This hypothesis suggested dichotomizing the "B" variable and summarizing the relationship between *frequencies* and B values by means of a statistic such as the biserial product moment r. The formula for r is as follows:—

$$r = \sqrt{\frac{p}{q}}\left(\frac{M_H - M_T}{\sigma_T}\right)$$

where p = proportion of plants in the group with the higher B values

$q = 1 - p$

M_H = Mean frequency of the higher group

M_T = Mean frequency of the total sample of plants

σ_T = Standard deviation of the frequencies of the total sample.

An alternative formula for the biserial product moment correlation coefficient may be written as follows:—

$$r = \left(\frac{M_H - M_L}{\sigma_T}\right)\sqrt{pq}$$

where the symbols are defined as they were for the formula above and M_L equals the mean frequency of the group with the lower B-values. From the alternative formula it can be seen that the magnitude of the r is a function of the difference between the mean frequencies of the higher and lower groups. The use of the biserial product moment r has the advantage over the simple difference in that it takes into account the variability in the total group and the proportions in the two groups thus making possible comparisons from one investigation to another.

Even though the original hypothesis had suggested dichotomizing at B=7 and higher to obtain the higher group, it was decided to investigate the correlation at other possible points of dichotomy. The results are presented in table IV.

TABLE IV.

BISERIAL PRODUCT MOMENT CORRELATION AT DIFFERENT POINTS OF DICHOTOMY.

Pt. of dichotomy	*p.*	$M_H - M_T$	*r*
B=10	.0537	110.66	.60
B= 9 and 10.. ..	.0829	100.47	.68
B= 8 and higher ..	.1268	71.20	.61
B= 7 and higher ..	.2195	56.71	.68
B= 6 and higher ..	.2878	43.24	.62
B= 5 and higher ..	.3659	32.59	.56
B= 4 and higher ..	.4000	28.77	.53

(*Note*:—Computations based on ungrouped data of table III).

The highest correlation viz. ·68 is obtained with the dichotomies at B=9 and B=7. It should be obvious that the B=7 is a more desirable point of dichotomy.

The biserial product moment r as a summary statistic of the relationship between *frequency* and B value was examined for data from two earlier investigations in order to check whether or not the dichotomy at B=7 and higher would have been best for those data. In one of the earlier investigations (Gard. Bull. XVII 1958) the r's for dichotomies at B=8, B=7, B=6, and B=5 were ·49, ·46, ·45 and ·39 respectively and in the second earlier investigation, the r's for dichotomies at B=8, B=7, B=6 and B=5 were ·61, ·56, ·49 and ·41 respectively. (Sarawak cf. Trans. Bot. Soc. Edn. 1959). These results would lead one to retain the B=7 dichotomy since they do not conflict with the present study and since the B=7 dichotomy was chosen on the basis of other considerations prior to the statistical analysis.

Having established the dichotomy at B=7 the 205 species can now be separated into two groups:—

Group I those species with B=7 and higher.
Group II „ „ „ B=6 and lower.

This dichotomy resulted in 45 species being classified in group I and 160 in group II. The species in group I clearly represent the important plants of the present community; the group II species are those occurring less regularly and in smaller frequencies.

The 45 species in group I were further classified into A. Trees, B. Shrubs, C. Lianes, and D. Herbs.

The 160 species in group II were classified into Group G—22 species and Group H— 138 species. This further classification is presented below.

The main defect in the description of the community is the absence of quantitative data on epiphytes.

Since the data for the 10 sub-samples were combined for each of the six groups A, B, C, D, G and H, the question arises as to whether or not each sub-sample can be considered with respect to the group under discussion as random sub-samples from the total sample.

The results are summarised in Table V.

Results

TABLE V.

		No. of specs.	No. of plts.	% of total plts.	
"B" = 7 or more	Group A. Trees ..	16	1,459	32.0	77.9
	„ B. Woody Plants ..	17	1,096	24.1	
	„ C. Lianes ..	11	987	21.7	
	„ D. Herbs ..	1	8	0.1	
"B" = 6 or less	Group G.	22	273	6.0	21.9
	„ H.	138	723	15.9	
		205	4,546	99.8	

Bartlett's test for homogeneity of variance again showed a lack of homogeneity in the five groups tested (the D group had to be omitted because of only one species in it). Thus the application of the F-test for an overall test of differences was again questionable. The forty-five mean differences were therefore tested for significance in each of the five groups. A summary of results is given in table VI. With the chance expectancy of no more than 3 "significant" differences among 45 at the ·05 level and beyond, the results showed no differences at the ·05 level or beyond for the A, B and C groups. For the G and H groups there were 4 and 6 differences respectively which were beyond the ·05 level although none of them reached the ·01-level. When the A, B, C and D Groups are combined, only 2 differences reach the ·05 level; the combination of G and H groups yields 4 differences at the ·05 level and 2 beyond the ·01 level.

These results suggest that the species in the A, B, C and D groups differ from those in the G and H groups in this forest area. Thus, all of the statistical analyses confirm the conclusion that the species in the A, B, C and D groups "belong" to this forest area while those in the G and H groups do not.

TABLE VI.

Means and Variances of the frequencies of the 10 sub-samples for each of the GROUPS.

Sub-sample No.	GROUP A		B		C		A+B+C+D		G		H		G+H	
	M	V	M	V	M	V	M	V	M	V	M	V	M	V
1	4.81	100.30	4.24	78.57	6.27	82.62	4.89	82.37	.45	.93	.30	.67	.325	.70
2	5.38	71.72	5.35	82.99	4.18	49.96	4.98	66.61	.45	1.21	.57	2.36	.556	2.20
3	11.88	236.25	5.29	62.22	11.09	289.69	8.93	180.25	.73	2.02	.58	2.89	.600	2.76
4	11.00	184.66	7.18	114.78	6.73	113.42	8.29	135.44	1.59	3.87	.64	3.37	.769	3.52
5	11.44	203.33	4.82	25.65	17.82	789.36	10.27	286.20	.82	5.01	.43	1.71	.488	2.15
6	11.31	206.10	6.53	91.01	7.82	98.96	8.42	131.61	1.00	13.14	1.16	15.30	1.14	14.92
7	8.50	104.00	14.88	460.74	6.64	39.05	10.27	226.93	2.55	16.55	.41	.84	.700	3.46
8	6.94	61.93	6.18	38.40	11.45	237.47	7.62	94.69	1.59	8.63	.31	.86	.488	2.08
9	7.44	53.73	3.76	15.94	7.91	98.69	6.02	50.70	1.77	9.99	.46	1.10	.638	2.48
10	12.50	199.07	6.24	56.32	9.82	177.76	9.20	138.12	1.45	4.93	.38	1.13	.531	1.76
Bartlett's Test..	19.2*		67.6**		38.3**		37.2**		76.2**		706*		507**	
No. of species	16		17		11		45		22		138		160	
No. of Differences between Means at .05 level and beyond ..	0		0		0		2*		4*		6*		4*+2**	

*.01 $<P<$.05 **P $<$.01

Group A, comprising those species whose mature individuals reach to canopy height, is listed in Table VII. Clearly dominance in this group could refer to the *Shorea spp.* but when Table XIII with a total of 513 Dipterocarps is taken into account the "family dominance" of the Dipterocarpaceae seems clear. It should be noted however that members of the Guttiferae (which includes *Garcinia* and *Calophyllum*) total 682 plants. Most of these (677) however fall into the first size class, the seedlings with a stem diameter less than one inch, and furthermore trees of these genera rarely reach to the height of the canopy.

TABLE VII.

GROUP A.—TREES

Species	Diameter Classes					Total	"B" Value
	0–1	1–3	3–5	5–7	Over 7		
Shorea macroptera ..	178	..	..	..	3	181	9
Shorea parvifolia ..	172	..	..	..	1	173	7
Shorea parviflora ..	83	..	..	..	..	83	10
Gironniera nervosa ..	26	2	..	..	1	29	8
Pygeum polystachyum	124	3	..	1	..	128	10
Onchosperma horridum	99	4	2	6	..	111	10
Garcinia griffithii ..	132	3	2	..	..	137	8
Santiria tomentosa ..	34	2	4	..	..	40	7
Dacryodes laxa ..	24	1	1	..	..	26	8
Quercus sp.	22	2	1	..	..	25	8
Lindera lucida ..	14	..	1	..	..	15	8
Dialium sp.	177	1	..	..	..	178	7
Coelodepas wallichianum	158	3	..	..	..	161	10
Melanorrhoea woodsiana	106	4	..	..	..	110	10
Gomphandra affinis ..	47	1	..	..	..	48	7
Elateriospermum tapos	14	..	..	..	..	14	7
	1,420	26	11	7	5	1,459	..

Group B, Table VIII lists the shrubs and small trees which do not reach to canopy height or potential trees which have not yet exceeded sapling size. The shrubs characteristic of this community are clearly *Agrostistachys sessilifolia* and *Aprosa benthamiana* (both Euphorbiaceae).

TABLE VIII.

GROUP B.—SMALL TREES AND SHRUBS

Species	Diameter Classes					Total	"B" Value
	0–1	1–3	3–5	5–7	Over 7		
Agrostistachys sessilifolia	234	4	..	..	..	238	10
Aporosa benthamiana	45	9	..	..	..	54	10
Cryptocarya griffithiana	16	2	..	..	..	18	7
Calophyllum pulcherrimum	182	..	..	..	..	182	9
Calophyllum inophylloide var. singapurense	149	..	..	..	..	149	9
Calophyllum ferrugineum	95	..	..	..	..	95	10
Xanthophyllum discolor	77	..	..	..	..	77	7
Garcinia parvifolia ..	52	..	..	..	..	52	9
Garcinia eugenifolia ..	35	..	..	..	..	35	8
Scorodocarpus borneensis	45	..	..	..	..	45	8
Anisophyllea disticha	36	..	..	..	..	36	9
Clerodendron disparifolium	27	..	..	..	..	27	7
Myristica crassa ..	24	..	..	..	..	24	7
Acronychia porteri ..	20	..	..	..	..	20	7
Eugenia longiflora ..	19	..	..	..	..	19	8
Eugenia sp.	12	..	..	..	..	12	8
Aquilaria malaccensis	13	..	..	..	..	13	7
	1,081	15	..	..	..	1,096	

Group C. Table IX gives the lianes present and the prominence of the family Connaraceae is noteworthy and is indicated by * in the table.

TABLE IX.

GROUP C.—LIANES AND CLIMBERS

Species	Diameter Classes					Total	"B" Value
	0–1	1–3	3–5	5–7	Over 7		
Willughbeia coriacea ..	285	..	..	..	..	285	10
Rourea sp.* ..	150	..	..	..	..	150	7
Rourea fulgens* ..	85	..	..	..	..	85	10
Agelaia sp.* ..	147	..	..	..	..	147	7
Psychotria ovata ..	109	..	..	..	..	109	10
Connarus sp.* ..	64	1	..	..	..	65	7
Fibraurea chloroleuca	51	..	..	..	..	51	7
Piper caninum ..	35	..	..	..	..	35	7
Tetracera indica ..	26	..	..	..	..	26	9
Ventilago sp. ..	19	..	..	..	..	19	7
Vitis macrostachya ..	15	..	..	..	..	15	7
	986	1	..	..	..	987	

Group D, Table X the true herbaceous plants—i.e. those which are not seedlings or saplings of trees, shrubs or lianes, are represented here solely by the fern *Tectaria singaporeana.*

TABLE X.

GROUP D.—HERBS.

Species	Total	"B" Value
Tectaria singaporeana ..	8	7

Group G, is listed in Table XI. This group is distinguished from the remainder of those with "B" = 6 or less by the fact that some of them have a stem diameter greater than 1" at breast height. At least the first 8 are large enough to be reproducing themselves and the comparative paucity of their seedlings is noteworthy.

TABLE XI.

GROUP G.

Species	Diameter Classes						
	0–1	1–3	3–5	5–7	Over 7	Total	B
Anispotera megistocarpa	8	..	..	1	1	10	5
Dialium maingayi ..	2	..	..	..	1	3	1
Dipterocarpus verrucosus	1	..	..	..	1	2	1
Dipterocarpus hasseltii	..	..	..	..	1	1	1
Litsea grandis ..	12	3	1	..	..	16	5
Macaranga lowii ..	8	..	1	..	..	9	3
Timonius wallichianus	4	..	1	..	..	5	3
Diospyros lancifolia ..	2	..	1	..	..	3	3
Eugenia sp. 4. ..	41	2	..	..	..	43	6
Litsea sp.	40	1	..	..	..	41	6
Polyalthia angustissima	24	3	..	..	..	27	6
Aglaia glabriflora ..	23	1	..	..	..	24	5
Horsfieldia subglobosa	16	1	..	..	..	17	3
Zygia jiringa ..	13	1	..	..	..	14	6
Ochanostachys amentacea	11	1	..	..	..	12	5
Eugenia polyantha ..	12	3	..	..	..	15	5
Hopea megarawan ..	8	1	..	..	..	9	4
Elaeocarpus sp. ..	7	1	..	..	..	8	6
Baccaurea parviflora ..	1	3	..	..	..	4	3
Galearia sp. ..	3	1	..	..	..	4	2
Knema hookeriana ..	1	2	..	..	..	3	3
Salacia flavescens ..	2	1	..	..	..	3	3
	239	25	4	1	4	273	

In contrast Group H, Table XII, with a total of 138 species represents plants which are seedlings or saplings of larger plants or rarely, and these are marked with an asterisk, Herbs of the forest floor.

TABLE XII.

GROUP H.

Species	Total	B	Species	Total	B
				261	
Actinodaphne pruinosa ..	5	3	Elaeocarpus ferrugineus	1	1
Adinandra dumosa ..	20	5	Elaeocarpus mastersii ..	2	1
Aeschynanthus sp. ..	2	1	Elaeocarpus petiolatus ..	1	1
Aglaia trichostemon ..	1	1	Elaeocarpus stipularis ..	1	1
Aglaia sp.	1	1	Elaeocarpus sp. ..	1	1
Aglaonema schottianum var. angustifolium* ..	13	3	Ellipanthus tomentosus ..	2	1
Alsodeia floribunda ..	1	1	Eugenia garcinifolia ..	15	2
Antidesma alatum ..	7	5	Eugenia grandis ..	1	1
Aporosa sp. ..	1	1	Erycibe maingayi ..	24	6
Apostasia nuda* ..	3	2	Ficus callicarpa ..	3	3
Aquilaria hirta ..	1	1	Ficus sp.	2	1
Ardisia teijsmanniana ..	1	1	Fissistigma latifolium var. ovoideum ..	9	4
Ardisia spp. ..	21	5	Fissistigma fulgens ..	9	3
Artabotrys costatus ..	1	1	Fordia filipes ..	10	6
Artabotrys susveloens ..	6	3	Galearia phlebocarpa ..	1	1
Arthrophyllum diversifolium	1	1	Garcinia gaudichaudii ..	2	1
Artocarpus anisophyllus	4	2	Garcinia mangostana ..	1	1
Artocarpus dadah ..	1	1	Garcinia sp. ..	1	1
Artocarpus integer ..	4	3	Glycosmis chlorosperma	38	6
Artocarpus lancifolius ..	11	3	Gnetum macrocarpum ..	2	2
Artocarpus scortechinii	6	7	Goniothalamus macrophyllum	1	1
Athyrium cordifolium ..	2	2	Goniothalamus malayanus	1	1
Blumeodendron tokbrai	1	1	Guioa pubescens ..	1	1
Byttneria maingayi ..	2	2	Gymnacanthera bancana	1	1
Caladium denudatum ..	2	2	Gynotroches axillaris ..	2	2
Calamus ornatus var. horridus ..	16	3	Helicia excelsa ..	1	1
Calamus javensis ..	21	6	Homalomena rubra* ..	2	2
Calophyllum sp. ..	29	2	Hoya ridleyi ..	1	1
Canthium horridum ..	5	2	Ilex cymosa ..	1	1
Centotheca latifolia* ..	1	1	Ipomoea maxima ..	1	1
Centrosema sp. ..	1	1	Ixonanthes icosandra ..	8	3
Champereia manillana ..	3	3	Ixora congesta ..	8	5
Chasalia chartacca ..	13	4	Ixora sp.	5	3
Chisocheton sp. ..	1	1	Knema communis ..	1	1
Cnestis palala ..	1	1	Knema malayana ..	8	4
Cordyline sp. ..	2	1	Korthalsia sp. ..	2	1
Cratoxylon formosum ..	2	1	Labisia pothoina* ..	16	4
Croton laevifolium ..	1	1	Lasianthus densifolius ..	4	3
Curculigo latifolia* ..	1	1	Lasianthus sp. I ..	12	5
Cyathocalyx ridleyi ..	1	1	Lasianthus sp. II ..	1	1
Cyathostemma viridiflorum	5	2	Lasianthus sp. III ..	1	1
Daemonerops sp. ..	21	6	Licuala sp. ..	6	5
Desmos dasymaschalus ..	1	1	Lindera sp. ..	1	1
Demsos dumosus ..	3	3	Luvunga sarmentosa ..	11	5
Dioscorea pyrifolia ..	2	2	Macaranga javanica ..	1	1
Dipterocarpus sublamellatus	1	1	Mangifera sp. ..	2	1
Dracaena granulata ..	1	1	Nephelium lappaceum	1	1
Dracaena umbratica ..	12	6	Oxymitra calycina ..	9	2
			Palaquium obovatum ..	10	3
			Pandanus ornatus ..	2	2
	261			511	

GROUP H—continued

Species	Total	B	Species	Total	B
	511			588	
Parkia speciosa ..	3	3	Sandoricum koetjape ..	4	3
Phaeanthus opthalmicus	1	1	Scleropyrum ridleyi ..	1	1
Philodendron sp. ..	2	1	Shorea sp. No. 4 ..	52	5
Phymatodes scolopendrium*	2	2	Sloetia elongata ..	2	1
Abarema elliptica ..	7	5	Smilax calophylla ..	3	2
Plectocomia griffithii ..	4	1	Strombosia rotundifolia	5	2
Polyalthia cauliflora ..	8	3	Strychnos ovalifolia ..	15	6
Psychotria helforiana ..	1	1	Strychnos sp. ..	3	1
Psychotria maingayi ..	1	1	Tabernaemontana malaccensis	26	6
Psychotria sp. ..	1	1	Urophyllum glabrum ..	6	5
Pternandra sp. ..	1	1	Urophyllum griffithianum	1	1
Ptychoraphis singaporeana	1	1	Vatica wallichii ..	1	1
Quercus sp. ..	1	1	Vitex pubescens ..	1	1
Randia anisophylla ..	9	4	Vitis gracilis ..	2	2
Randia incurva ..	1	1	Wikstroemia ridleyi ..	1	1
Randia longiflora ..	10	5	Xanthophyllum sp. ..	1	1
Randia macrophylla ..	20	5	Xylopia ferruginea ..	1	1
Raphidiophora sp.* ..	2	2	Zizyphus horsfieldii ..	7	5
Rhodamnia trinervia ..	2	2	Unknowns	2	1
	588			722	

TABLE XIII.

DIPTEROCARPACEAE.

DIAMETER CLASSES

Species	0–1	1–3	3–5	5–7	Over 7	Total	B
Shorea macroptera ..	178	..	..	..	3	181	9
Shorea parvifolia ..	172	..	..	..	1	173	7
Shorea parviflora ..	83	..	..	..	..	83	10
Shorae sp. No. 4 ..	52	..	..	..	..	52	5
Anisoptera megistocarpa ..	8	..	..	1	1	10	5
Hopea mengarawan	8	1	..	..	..	9	4
Dipterocarpus verrucosus ..	1	..	..	..	1	2	1
Dipterocarpus hasselii	..	..	..	..	1	1	1
Dipterocarpus sublamellatus ..	1	..	..	..	..	1	1
Total ..	504	1	0	1	7	513	..

Table XIII summarises all the data of the family Dipterocarpaceae, totalling 513 records. This total, 513, represents 12 per cent of the total of plants recorded from the transect.

In conclusion the naming of the community gives little difficulty in terms of previous proposals (Gilliland, H. B., 1958). This is a *Shorea/Agrostistachys* community.

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The pH of Rain Water from the Botanic Gardens

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The hydrogen ion concentration of rain water is always very small, typical samples containing from 10^{-5} to 10^{-8} moles of hydrogen ion per litre. Because the values are so small, it is convenient to represent the data in terms of pH, *viz.* the negative of the logarithm of the hydrogen ion concentration. On this scale, we would say that typical samples of rain water range from pH 5 to pH 8. If the pH is 7, we say that the rain water is neutral, if it is less than 7 it is acid and if it is greater than 7 it is alkaline.

Chemically pure water has a pH of 7 but rain water in the course of its condensation in clouds and passage through the atmosphere, can dissolve gases such as carbon dioxide, oxides of nitrogen and ammonia, which contribute to the pH, and also dust particles normally present in the atmosphere or discharged into the atmosphere during building operations, etc. The pH is also affected by any trace of alkali dissolved from glass containers.

The pH of the rain water falling in the Botanic Gardens has been examined over a three year period, March 1956 to February 1959 and, during the last ten months measurements have also been made on rain water samples collected at the University of Malaya. pH measurements were made in the usual way with a glass electrode standardised by a phosphate buffer. These pH values are not equilibrium properties for they change with time as dissolved gases escape and a further supply of gas is absorbed from the atmosphere; nevertheless, if the collection of samples and the method of measurement are uniform, the results should have some significance.

The results are too numerous to tabulate in detail but a summary is given in Tables I and II. Some features that stand out are as follows:—

(1) There is a very wide variation in pH even in a period of one month. The average spread in a month was 1·45 pH units but in February 1957 the pH varied from 5·03 to 7·81, a difference of 2·78 pH units whilst in July 1958 it varied only from 6·71 to 7·32, a difference of

only 0·61 pH units, in the Botanic Gardens although values between 4·85 and 6·52 were observed with the University samples. The highest value recorded was 8·16 (19 November, 1957) and the lowest was 4·58 (14 November, 1958), the latter being at the University site.

(2) There is an astonishing difference between the pH values found for samples taken in the Botanic Gardens and those from the University site only seven chains away. In all months from May 1958 to February 1959, the pH was between 0·44 and 1·38 pH units lower at the University site, the average value in the Botanic Gardens being 6·80 compared with 5·86 in the University. Whilst the total rainfall was about the same at the two sites—89·61″ in the Botanic Gardens and 87·48″ at the University, there is considerable difference in the distribution from month to month. Thus in June, 1958, 11·89″ were recorded at the University against 11·90″ at the Gardens but in November 1958, 18·75″ fell at the University site compared with 21·65″ at the Gardens.

An examination of the records of thunderstorms made at Singapore airport (some distance from the Botanic Gardens) shows that on the 139 days of thunderstorm on which samples were obtained from the Gardens, the average pH was 6·56 compared with 6·65 for the total of 548 samples. Some diminution in pH such as this would be expected as the result of the formation of oxides of nitrogen during thunderstorms.

On the days when no thunderstorms were recorded, there is some indication that a rainfall of less than 0·2″ gives rainwater of average pH about 6·85: there seems to be no appreciable variation if the rainfall is between 0·2″ and 2·25″, the pH being about 6·43 but on the six occasions only on which a higher rainfall occurred, the average pH fell to 5·86, approaching the value, 5·68, expected for water saturated with carbon dioxide in equilibrium with atmospheric carbon dioxide. It would be interesting to confirm this with more samples.

(3) The month of January 1957 gave inexplicably low pH values, averaging 5·92, at the Botanic Gardens.

(4) Twenty-two times during the period May 1958 to January 1959, we were able to obtain not only composite samples from the Botanic Gardens but also the final sample left in the Recording Rain Gauge. The results are given in Table III. The first ten results tabulated refer to days in which more than one inch of rain fell in the Botanic Gardens and thunderstorms were noted at the same time at Singapore Airport. The rest of the results refer to days on which more than an inch of rain fell but no thunderstorms were noted. With the reservation that only a small number of results are available, some conclusions are suggested.

On days without thunderstorms, the average pH, 6·44, of the composite samples was almost that of the final sample, 6·43. We have noted in section (3) that over the entire period of the tests rainfalls between 0·2″ and 2·25″ tend to give a pH about 6·43. We might have expected a lower pH for the final samples from the rain gauge, in view of the statement in section (3) that rainfalls greater than 2·25″ tend to a low pH of 5·86 but it will be noted from Table III that the value of 6·43 for the final samples from the rain gauge is based on twelve samples and in only one instance did the total rainfall exceed 2″. The findings in this section and in section (3) are, therefore, not contradictory. The average pH of the composite samples on days of thunderstorms was 6·31: over this period the average of all samples was 6·80. This would suggest a considerable diminution of pH as a result of thunderstorms, greater than the difference noted in section (3). However, the average of 6·80 was deduced from all samples, even if the rainfall was only a few hundredths of an inch: we have already noted that such small rainfall has comparatively high pH, thus raising the average value. A fairer comparison would be between days with and days without thunderstorms, each with over an inch of rain; i.e. we compare an average of 6·31 in the first instance with 6·44 in the second. The influence of thunderstorms is now more consistent with that noted in section (3).

The average value of the final samples from the rain gauge on days with thunderstorms was 6·46, close to that on days without thunderstorms: this suggests that the first inch of rain succeeds in washing the atmosphere free of oxides of nitrogen.

Table I

pH OF RAIN WATER FROM THE BOTANIC GARDENS

	pH (average)	*pH (minimum)*	*pH (maximum)*	*Number of days on which rain fell*	*Monthly rainfall (inches)*
1956					
March ..	6.41	5.70	6.95	11	4.28
April	6.72	6.30	7.09	10	2.68
May	6.57	6.23	7.33	19	10.49
June	6.59	5.81	6.87	13	5.67
July	6.36	5.95	6.79	16	13.82
August ..	6.40	5.29	6.92	24	8.90
September ..	6.36	5.18	7.19	19	12.05
October ..	6.26	4.95	7.48	20	4.82
November ..	6.66	5.50	8.16	21	19.30
December ..	6.73	6.19	7.09	17	8.32
1957					
January ..	5.92	4.69	6.88	14	4.81
February ..	6.56	5.03	7.81	8	4.09
March ..	6.28	5.38	7.42	13	6.98
April	6.89	5.84	7.28	9	3.91
May	7.11	6.40	7.77	16	12.20
June	6.47	5.61	7.12	10	2.92
July	6.67	5.89	7.15	15	8.98
August ..	6.71	6.32	7.18	15	4.65
September ..	6.79	6.09	7.69	19	10.27
October ..	7.11	6.67	7.67	13	2.33
November ..	6.69	5.82	7.51	21	6.45
December ..	6.79	4.52	7.29	25	11.40
1958					
January ..	6.85	6.62	7.48	13	7.79
February ..	6.76	5.98	7.33	13	5.68
March ..	6.73	6.16	7.22	11	3.68
April	6.78	6.24	7.39	12	3.45
May	6.99	6.62	7.47	18	7.44
June	6.85	5.82	7.69	14	11.90
July	6.88	6.71	7.32	8	2.19
August ..	6.91	5.88	7.18	17	12.81
September ..	6.97	6.76	7.38	14	3.18
October ..	6.58	5.88	7.28	18	12.35
November ..	6.51	5.89	7.33	20	21.65
December ..	6.89	6.50	7.28	12	4.43
1959					
January ..	6.78	5.59	7.49	19	9.78
February ..	6.63	5.98	7.19	10	3.88

Table II

pH OF RAIN WATER FROM THE UNIVERSITY SITE

	pH (average)	*pH (minimum)*	*pH (maximum)*	*Number of days on which rain fell*	*Monthly rainfall (inches)*
1958					
May	6.56	5.14	7.29	19	5.54
June	5.89	4.95	7.12	15	11.89
July	5.76	4.85	6.52	7	3.19
August ..	5.53	4.85	6.16	15	13.85
September ..	6.04	5.44	6.69	9	3.00
October ..	5.65	5.04	6.37	15	11.58
November ..	5.48	4.58	5.83	16	18.75
December ..	6.00	5.52	6.33	8	4.70
1959					
January ..	5.92	5.56	6.39	11	10.38
February ..	5.77	4.59	6.72	9	4.60

Table III

DATA FROM RECORDING RAIN GAUGE IN BOTANIC GARDENS

Date	*Time of Thunderstorm*	*Time of Rainfall*	*Composite Sample Inches*	*pH*	*Final Sample Inches*	*pH*
25–5–58 ..	0830–0920	0810–1000	1.52	6.62	0.52	7.20
12–6–58 ..	0720–0755	0630–0730	1.10	5.82	0.10	6.19
29–8–58 ..	0615–0755	0505–1015	1.89	6.30	0.89	6.18
8–10–58 ..	0510–0630	0415–0900	1.13	6.74	0.13	6.82
22–10–58 ..	1040–1150	0930–1130	2.92	5.88	0.92	6.06
1–11–58 ..	0240–0350	0135–0735	1.82	6.16	0.82	6.10
1–11–58 ..	1755–2055	1830–2200	1.48	5.89	0.48	6.49
16–11–58 ..	1530–1620 2305–2320	1445–1630 2145–2400	1.37	6.02	0.37	6.33
24–11–58 ..	0130–0345	0100–0335	1.25	6.68	0.25	6.90
27–11–58 ..	1730–1820	1630–1800	1.31	7.03	0.31	6.28

Date	*Composite Sample Inches*	*pH*	*Final Sample Inches*	*pH*
6–5–58	1.82	6.93	0.82	6.83
22–6–58	1.95	6.50	0.95	7.10
29–6–58	1.97	6.70	0.97	6.39
17–8–58	1.90	5.88	0.90	6.04
18–8–58	1.08	6.18	0.08	5.76
1–10–58	1.68	6.89	0.68	6.51
14–11–58	1.81	6.18	0.81	6.42
15–11–58	1.24	6.10	0.24	5.81
17–11–58	3.61	6.08	0.61	5.90
18–12–58	1.32	6.27	0.32	6.34
6–1–59	1.99	6.84	0.99	7.00
12–1–59	1.20	6.72	0.20	7.07

In the latter part of the table, the rainfall refers to a 24 hour period commencing at 0800 on the day noted in the first column.

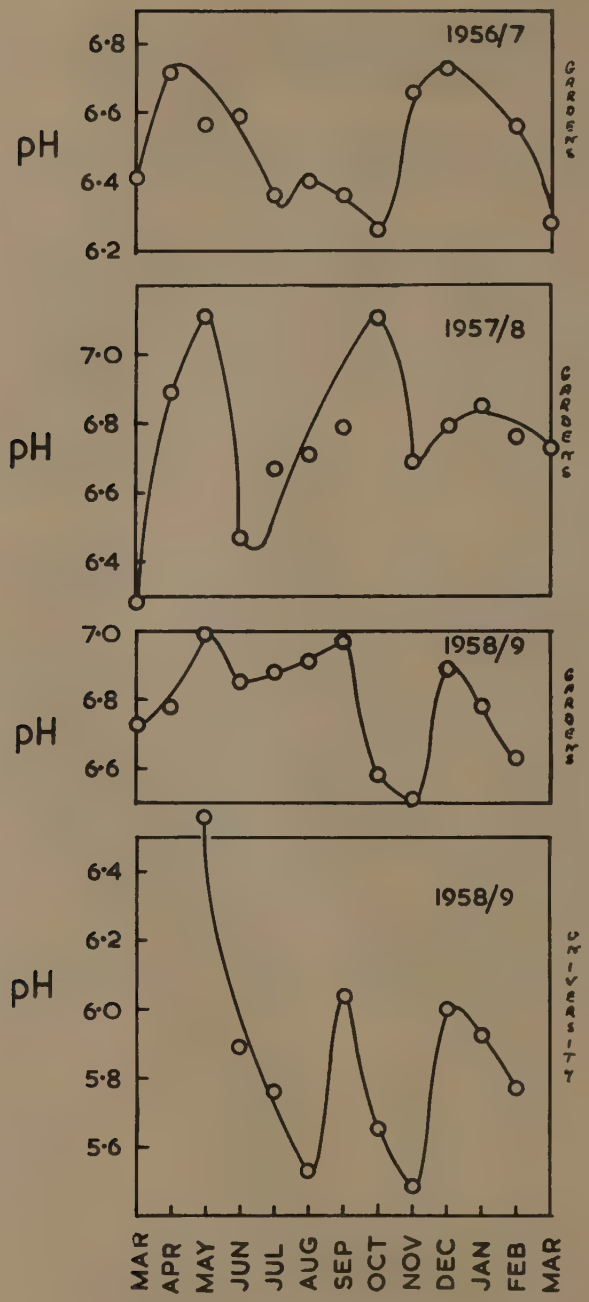
(5) In spite of these variations from day to day and from site to site, the graph of average monthly pH plotted against time shows some remarkable features (Fig. I).

After the first year's measurements had been completed, it was thought that the variation with time was characterised by two maxima, one in April and the other in December. It could well be argued that the small maximum in August is due to a chance fluctuation. This maximum appears, however, in the graphs for each of the succeeding years. It is also remarkable that the data for the University site show the same variation although the monthly pH values are uniformly lower and the incidence of rainfall different. All four graphs show maxima one about April or May, a second about September and a third about December. It may be significant the first two maxima occur at the beginning and at the end respectively of the South-West monsoon: the third maximum occurs about half way through the North-East monsoon.

The measurements described in this paper were not designed as an elaborate study: at first, we were interested only in answering a question which arose from some work on the corrosion of metals: what is the average pH of Singapore rain water? In the course of this work a number of related problems suggested themselves, some of which have been described. The answers we have given are tentative because the original experiment was designed for one purpose only. If this work could be continued, several modifications could be suggested, such as the collection of separate samples during thunderstorms, the observation of thunderstorms from the site of sampling and not from a distant observation post, and the examination of samples for nitrite and nitrate.

I am grateful to Professor Gilliland, Mr. Purseglove and Mr. Burkill for the collection of samples and to Mr. Mather for the provision of meteorological data.

Figure 1


1956/7
GARDENS
pH
6·8
6·6
6·4
6·2
1957/8
GARDENS
pH
7·0
6·8
6·6
6·4
1958/9
GARDENS
pH
7·0
6·8
6·6
1958/9
UNIVERSITY
pH
6·4
6·2
6·0
5·8
5·6
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR

Botrychium daucifolium Wall.
from Cameron Highlands

Malayan Fern Notes

By B. Molesworth Allen

A preliminary note

Botrychium daucifolium Wall. ex Rac., Flor. Btz., I. 4. (1898). The genus *Botrychium* has not previously been recorded for Malaya. Holttum however, when discussing the Ophioglossaceae in "Ferns of Malaya" (1954), page 38, notes: "*Botrychium* occurs in both Borneo and north of Malaya, so that it may occur in mountain forests in Northern Malaya." Thus it was not surprising when I found it in the Cameron Highlands area of Pahang in April 1958.

The plants agree with the description of *B. daucifolium* given by van Alderwerelt van Rosenburgh in "Malayan Ferns" (1908) page 778 (the *forma typica* of his supplement (1916), page 455). Most are a little smaller than his measurements, and the segments of the sterile frond are inclined to be coarsely toothed. I have not seen Wallich's description, so do not known whether the presence of copious pale hairs on very new growth and the almost glabrous state of the mature fern, is typical. This is not mentioned in any description I have seen, but Beddome's illustration in "Ferns of British India & Ceylon" (1892), page 470, shows a very hairy stipe and rachis of an adult plant. This is not described in the text. None of my mature or nearly mature specimens approaches this state.

The path to Gunong Perdah, for about one mile past the Gunong Jasah turnoff, follows a more or less flat contour, along the sloping sides of the hills, which are clad in tall rain forest. This is at about 5,000 feet in altitude. Here nine plants of *Botrychium* were found in a small area of about two square metres, where there was a slight opening in the tall dark forest. Apparently a tree had fallen sometime previously widening the opening already made by the path. In the immediate vicinity there were no plants growing between the tall saplings which were nearly two metres high, and the scattered plants on the forest floor. The tallest of the latter were about 45 cm., and were mostly a species of *Didymocarpus* and young *Cyathea* species.

The earth was rich in humus being black and sticky, and the situation was some distance above a stream. The *Botrychium* plants were a paler green than the surrounding vegetation and showed up

clearly. The largest plant measured was nearly 36 cm. tall and had the remains of a very old fertile spike which projected beyond the sterile portion of the lamina. The sterile leaves were also past maturity, but there was one very new and uncurled frond, most parts of which were covered with transparent spreading hairs. All the older fronds examined were almost, or quite, glabrous. Amongst the other plants there were only two fertile spikes, both being very new, but many of the other fronds still showed where a fertile spike had been. Two of these can be seen in the accompanying photograph.

Although the adjacent ground, both above and below the path was searched, no more plants were found here, but further on towards the Jasah turnoff, eleven more were found. They occurred sporadically on the pathside for about half a mile, in similar places to the first lot except that there was seldom as much light on the forest floor. Most of these had new fertile spikes which were often nearly mature.

Further field observations are necessary to determine whether *Botrychium* dies off in the same way as some of the other Ophioglossaceae in Malaya. The presence of bases of old fertile spikes rather suggests that they do not do so, yet a plant may produce more than one fertile spike in one season before a die-back. I had hoped to return in July, but new emergency regulations have closed this area, so no further notes have been made since the first collection.

Botrychium may not be uncommon in these forests where the floor is flat and where damp (not wet) conditions prevail. They appear to require a certain amount of light so perhaps the normal tall jungle provides only a temporary habitat after an opening has been made, and before other plants of more vigorous growth cover the ground. The path here no doubt, has provided this sort of habitat, for since the emergency it has remained practically undisturbed. Saplings on the path edges have become tall and so have kept that part of the floor fairly clear. The saplings are now however, at a height where the undergrowth can and probably will start covering the ground again. So possibly *Botrychium* may be on the decline here. It will be interesting to see the position in a year's time, and probably much will depend on whether the paths have been cleared. Perhaps the original habitat is in the light shade provided by the smaller trees in the *padang* areas of higher altitudes.

A living plant is at Kew and herbarium specimens *No. 3930* were sent to the herbaria of Kew and the Singapore Botanic Gardens.

Malayan Fern Notes, II

By Betty Molesworth Allen

Malayan hill stations are always interesting botanically, especially so where the clearing of jungle is still taking place and therefore the plant formation is continually changing. In the past, however, cleared areas such as roadsides, lawns, golfcourse and garden edges and forest paths have been kept cut for so many years that small, light loving plants, both native and introduced have often become established. Now, because of the present emergency, some of these areas have remained almost undisturbed for nearly ten years, allowing a taller and different succession of plants to take over. Many paths through the jungle received little or no clearing, and in the Cameron Highlands district of Pahang, some of the gardens of remoter bungalows became neglected. In the lower part of the now deserted garden of one such place, Walkerburn Cottage, several interesting ferns have become established amongst short second-growth and lank grass. These include *Cyathea excavata, Cystopteris tenuisecta, Athyrium amplissium, Merinthosorus drynarioides, Thelypteris beddomei* and *T. brunnea.*

The fairly new car road to the summit of Batu Brinchang, a mountain of 6,666 feet in the Cameron Highlands area of Pahang, enables the botanist to spent more time and energy at its higher altitudes. Here on clearings caused through roadmaking, colonisers (seen in 1956) were small, some being rare plants which will no doubt disappear when larger plants become established. In fact this has already begun to happen and in two years there has been a marked change on some of the higher mist swept ridges over which the road runs. It is a pity that some systematic record could not have been kept of these early stages of plant succession, for in the past six years or so, roads have been built up to other summits and high ridges of Malayan mountains for V.H.F. wireless stations.

In 1956 on Kedah Peak in Kedah, I found that the then unfinished road up the last part of the very steep and narrow summit, had already influenced plant growth below. The road was draining water away from the flatter ground above the resthouse where previously large patches of *Sphagnum* were common in the wet ground. Most of these patches had disappeared together with the little local *Schizaea malaccana* Bak., which grew amongst the *Sphagnum*, and the ground was very dry and almost devoid of plant growth.

Again the emergency has contributed directly to a changed vegetation in places in the lowlands. Previously fertile ground such as riverine areas and terrain near the bases of limestone hills (especially in the Ipoh district of Perak) have for many years been under almost continual cultivation. During the emergency these areas were cleared of squatters and put under curfew. Thus neglected for nearly ten years, the rich soil together with the moist hot climate induced a quick succession of *belukar* (a local name for secondary scrub formation). In many places this resulted in a growth tall and thick enough for terrestial ferns, which would not tolerate full sun, to appear. For instance, *Phymatodes longissima* (Bl.) J. Sm., apparently not a common fern in Malaya, is now abundant in *belukar* in these places around the Ipoh district. With better political conditions approaching however, curfews have been lifted in many of these places and people are going back on to the land. Since June 1958 many areas have been cleared again by cutting and burning, and already much is under vegetable cultivation. Thus possibly 1959 will see the end of this interesting decade of undisturbed *belukar* near the towns.

The order of the following annotated list and the nomenclature, follows those used by R. E. Holttum in his "Ferns of Malaya", 1954, and the page number of the species discussed, is given in brackets.

All collecting numbers quoted are of my personal series, the specimens being either in my private collection or in the herbarium of the Botanic Gardens, Singapore. Duplicates have been distributed to other herbaria including Kew and the British Museum (Natural History).

The list contains results of field observations, including some extensions of known distributions and notes on two species of ferns not previously recorded from Malaya.

Trichomanes motleyi v.d.Bosch, (Holttum p. 92).

Growing on the vertical side of a large boulder in a stream bed in tall forest on the lower slopes of Penang Hill, at Batu Ferringhi. April 1956. Previously known from Singapore, Pahang and Selangor. Fertile fronds were common but the specimens I found in Kepong, Selangor which were in a similar habitat, had, in August, very few fertile fronds. I have since found it on a tree trunk about two feet from the ground, in a stream in tall forest at Ginting Simpah, Selangor. Penang specimen no. 2795.

Cyathea excavata Holttum, (Holttum p. 121).

So far this fern is known only from Cameron Highlands in Pahang. Holttum states (p. 122)* that only old sori have been seen. In August 1956 I found fertile fronds with immature and newly mature sori and the following description is taken from several large plants growing either in open or fairly open places in Cameron Highlands.

The largest middle pinnae measured were up to 63 cm. long (commonly 60) by 20 cm. wide, usually short stalked. It will be seen that these measurements are somewhat larger than those given by Holttum. Unless the frond is past maturity the lobes are much closer together than their own width when living and the edges are nearly always conspicuously toothed, sometimes lobed, being entire only towards the apex. Veins were forked up to four times, two to three being usual. The smooth stipes were almost black at the bases, but were green higher up. I found practically no scales on the stipe, even when young; they were present only on the very new and curled fronds. These scales were not thin, but fairly thick and large (often over 1·5 cm. long). Sori were 1 to 4 (commonly 1 to 2) at the bases of the pinnule lobes near the costae. Mature sori coalesced when dry, obscuring the lower part of the costules. Fronds frequently produce very few sori; a pinnule being fertile for only half its length, and the frond itself being sterile towards its apex. The very thin transparent indusium completely covers the young sporangium, but appears to break down at a very early stage of maturity. I have found that in pressed specimens, if the sporangia have burst during the process of drying, they seldom show any traces of indusia, yet if they have reached maturity normally before drying, some vestiges can be seen as described by Holttum. One and sometimes two, dark brown thin appendages similar to paraphyses were noticed attached to the base of a sorus, curving round it to about half its height. I saw these only on large fronds when the sori were immature. Paraphyses amongst the sporangia were not seen.

In the field this fern is most distinct from other species of *Cyathea*. The fronds when living are pale green, soft and inclined to hang laxly. A distinctive feature, not found to the same extent in any other Malayan *Cyathea,* is that the old dead fronds remain on the trunk, hanging down more or less concealing it, in much the same way as in some *Dicksonia* species. Another field character, but I am not sure how constant this is, is that all the plants seen had more than one trunk. Two was usual, but occasionally there

* From "Ferns of Malaya" unless otherwise stated.

were three, and on these trunks, at their bases, and up to about 60 cm., young adventitious plants were growing (I have seen the same in *C. recommutata* Copel. and in *C. polypoda* Bak.). One plant had become quite large and had fertile fronds.

Three mature plants of *C. excavata* were found fairly close together by a stream above Sultan Abu Bakar Road near Brinchang village in 1956, at about 5,000 feet altitude. In 1958 several more were found in this area and others at Taman Sedia, which is about 4,500 feet. Since then more plants have been seen in open or semi-open places, but only in the Cameron Highlands area. It appears to prefer streamsides, well above the normal water level, on forest edges. In Taman Sedia however, they were growing in open grassy places where there was only an occasional small tree and several tall specimens of *Cyathea contaminans* (Hk.) Copel. *C. excavata* appear to be on the increase where streamsides have been cleared or partially cleared, and some plants have grown a great deal since first seen here. Trunks 150 cm. high were not uncommon, and some were higher. The plants at Taman Sedia at least, are undoubtedly in an artificial habitat, for Holttum originally found *C. excavata* in shady forest by small streams, so it will be interesting to watch their development if they are left undisturbed.

Colysis acuminata (Baker) Holttum, (Holttum p. 162).

Sungei Buloh, Selangor; on the base of a large tree and on the ground beside a stream, well below the flood level; tall lowland forest; rare. March 1952, specimen no. 1875; June 1953, no. 2387.

Previous records are from Perak and Pahang. Holttum says that it occurs in the same situations as *C. macrophylla* (Bl.) Presl, which I did find near the Selangor specimens, but I have only found *C. acuminata* in association with streams and growing where it must frequently be inundated. In Perak it grows on rocks in the beds of small shallow streams. *C. macrophylla* on the other hand is more common in flat places in moist lowland forest, but not necessarily near streams.

Loxogramme scolopendrina (Bory) Presl, (Holttum p. 168).

Batu Caves, Selangor; January 1956; specimen no. 2686. Near the summit of this limestone hill, probably about 900 feet altitude. It was growing in a pocket of earth on steep ground and was rare.

Holttum lists this species from Pahang, Perak and Kedah.

Aglaomorpha heraclea (Kze.) Copeland, (Holttum p. 185).

Cameron Highlands, Pahang; altitude 5,000 feet. Although this fern record is only 500 feet higher than the highest altitude given

in "Ferns of Malaya", it has been included, as all the plants seen in the forest were small and infertile, indicating that they may be of recent origin. In June 1958 plants were seen on trees in tall forest on the slopes of Gunong Jasar and G. Purdah. They were not uncommon here. In the garden of Walkerburn Cottage at about the same altitude there is a large clump of *Aglaomorpha heraclea* perching on an *Erythrina* sp., and this was fertile in June.

Merinthosorus drynarioides (Hook.) Copeland, (Holttum p. 186).

The following are some field observations on this fern which has been recorded from several localities in Malaya.

In February 1948 I first saw a plant of *Merinthosorus* on a rock in a fairly open place near Robinson's Falls at Cameron Highlands, Pahang, at about 4,500 feet in altitude. It was small and not fertile, but the rhizome scales distinguished it from *Aglaomorpha heraclea* which it resembles in leaf character. When I visited this area again in 1956 the fern was no longer there, but I subsequently found another plant on a concrete wall, in almost full sun in the deserted garden of Walkerburn Cottage, near Brinchang village. Here the altitude is about 5,000 feet. The plant was young and infertile then, and so far (1959) has not produced sori although it has increased in size.

I have not seen *Merinthosorus* growing elsewhere at this altitude in the Cameron Highlands area, but it is common as an epiphyte on tall trees from Ringlet (*circa* 3,500 feet) downwards, until the jungle gives way to rubber estates, and they can be seen from the road. I have seen this fern in the following localities in Malaya:—

PERAK: Maxwell's Hill, on rocks in open places near the bungalows at 3,200 feet in altitude; on canopy trees in tall forest at 2,400 feet. On road to Cameron Highlands (but still in Perak), on a vertical rock bank beside road at c.3,000 feet (mostly young plants); high up on canopy trees in tall forest at c.1,700 to 3,500 feet. PAHANG: Cameron Highlands district on rock and wall in open places; Fraser's Hill, common on stone walls by bungalows*, about 4,000 feet altitude; on large boulders in a meadow at Jeriau Farm, 3,400 feet. SELANGOR: In tall forest common from about 1,500 to 3,000 feet, below and above the Semangkok Pass (The Gap); Ginting Simpah, on Rain Trees (*Enterolobium saman*) which have been planted on the roadside at the 17th milestone, at about 1,000 feet altitude; on tall forest trees in the forest near this altitude.

* In June 1958 most of the ferns from the stone walls had been removed.

I have not found *Merinthosorus* on Penang Hill (from where it was originally collected in Malaya) although I have searched for it during three months when I was living on the hill.

Merinthosorus in common with other acrostichoid ferns in Malaya, only periodically produce fertile fronds. In this genus however, it is almost certain that they are developed twice a year, (not just once a year, as for instance is the case with *Elaphoglossum* spp.) and possibly more frequently on rock walls. The latter may be induced by the frequent cutting back that they receive. The following, although not yet complete, show the months during which fertile fronds have been observed. *Fertile on rocks:*—Maxwell's Hill, February and November; Fraser's Hill, April, August and December. *Fertile on trees:*—Maxwell's Hill, November; road to Cameron Highlands, June and August; above and below the Semangkok Pass, June, December; Ginting Simpah, June. Only Fraser's Hill has been observed during December.

In 1957 I was able to watch the development of some *Merinthosorus* plants which were growing on the previously mentioned Rain Trees at Ginting Simpah. Although these plants must be fairly recently established, they were mature, and had the advantage of being easily and frequently seen. During February and March there was no noticeable growth, only sterile fronds being present, but during April new (sterile) fronds appeared. A few weeks later the bases of each of these new fronds became brown and dead-looking for less than one-quarter of their length, the rest remaining green. This gave a remarkable resemblance to the scale or nest-leaves of a Drynaria, and the plant from a distance would surely be taken for *D. sparsisora* (Desv.) Moore. It was the beginning of May when the bases turned brown, and a month later the fertile portion appeared on these new fronds. Since then I have observed similar growth on other *Merinthosorus* plants on trees by the Cameron Highlands road. Although this scarious condition of the frond has been noted previously, I am not aware that its development has been described. This, and the fact that it is epiphytic on uppermost branches and on crowns of very tall canopy trees in dense forest, is probably the reason that it has escaped notice in these places for so long. This habitat I believe is almost certainly the natural one in Malaya.

In the north of Malaya at least, *Merinthosorus* is probably quite common high up in the large trees of tall midmountain forest where the humidity is high. Even so, field glasses are often necessary to detect the fern. On rocks in open places and at hill stations I think it is most probably of recent origin, appearing after the

jungle was cleared and that it will increase in these areas, for it appears to adapt itself easily to the sides of large rocks and walls where there is good drainage.

Polypodium prainii (Bedd.) C. Chr., (Holttum p. 204).

Holttum describes this only as an epiphytic fern. It is still very common at Cameron Highlands in Pahang, but I have found, with only a few exceptions, that it is terrestial there. It grows where there is abundant moss and liverwort both on rocks and wet rocky ground, above streams where there is often much undergrowth and little light. It may have become a terrestial fern by adoption in areas where the tall trees have been removed, for branches are usually left in the forest, and it is in such places that it has been seen most commonly. It occurs quite frequently however, on the ground on the lower slopes of Brinchang and Jasar mountains where the tall forest appears to be little disturbed.

Polypodium prainii appears to have a seasonal die-back. In July only very old fronds were seen, and none were found in the same area in August, but when again visited in late September, new fronds were common. I have never seen it at Fraser's Hill.

Christiopteris tricuspis (Hook.) Christ. (Holttum p. 211).

Slopes of Gunong Terbakar in the Cameron Highlands district of Pahang, at 3,800 feet, August 1956.

Plants of this fern were growing out of the base of a large plant of *Aglaomorpha heraclea,* which was on a tall tree in a very exposed position. The *Christiopteris* had fertile fronds. It was not seen elsewhere here, but should be looked for wherever large clumps of *Aglaomorpha* grow, for it has only been found in association with this fern.

The accompanying photograph shows a small fourth lobe on a fertile frond of *Christiopteris* from Fraser's Hill. The frond was taken from a plant which is more or less established on the ground at the base of a fallen *Aglaomorpha* on the roadside near Pahang bungalow. This development has not been previously observed in Malaya, and all other fronds from this plant had the normal three lobes.

Since writing the above, more plants of *Christiopteris* have been found at Kuala Terla at Cameron Highlands, at 3,800 feet altitude. They were young and infertile, growing from an *Aglaomorpha* on a tree over the Terla River.

Grammitis crispatula Holtt., (Holttum p. 218).

Maxwell's Hill, Perak, February 1952. Herbarium specimen no. 1828. Although originally found in this locality, the fern does

not appear to have been seen in recent years. My field notes state that there were only a few plants and these were growing on a very large moss-covered rock in tall jungle, on a ridge just below 3,000 feet, but not anywhere near a stream. The fronds were dull and dark green with conspicuously crisped edges. My identification was kindly confirmed by Dr. E. B. Copeland to whom I sent a specimen with viable spores.

Ctenopteris celebica (Bl.) Copeland, (Holttum p. 233).

Robinson Falls, Cameron Highlands, Pahang, at about 4,500 feet. August 1956. This fern was not seen elsewhere and was found on a sloping mossy tree trunk in a very damp place overhanging the river. It was growing amongst *Hymenophyllum badium* Hk. & Grev. and *Grammitis hirtella* (Bl.) Tuyama. Fronds when living were pale yellowish and dull, with conspicuous red hairs on the stipes. Some of the fronds had new sori. The tree has since been destroyed by blasting operations for the new hydro-electric dam, but it surely must occur elsewhere here. Specimen no. 2895.

Thelypteris brunnea (Wall.) Ching, (Holttum p. 240).

This fern has obviously increased greatly in recent years for it is now very common at Cameron Highlands, growing in grassy places in full sun, by streamsides in shade, and on banks by roads. It sometimes becomes very large in the first mentioned habitat, largest fronds measured being nearly 200 cm. long including stipe, 160 cm. being about average.* The stipe is always shining and rather red. I have however, examined many plants from Camerons and from Fraser's Hill and have found in every case that the stock is either erect or suberect, but never long-creeping which is characteristic of this species. I have collected *Thelypteris brunnea* on Mt. Kinabalu in British North Borneo and although the fronds appear similar, the rhizome is entirely different, being creeping, with fronds widely spaced and not bunched as they are in Malayan specimens.

I have found what I consider to be normal *T. oppositipinna* (v.A.v.R.) Ching at both Cameron Highlands and Fraser's Hill, but never commonly. In the field it looks very different from *T. brunnea,* yet there is very little real difference, and I have found them growing together. The late Mr. Alston of the British Museum, to whom I sent specimens of *T. brunnea* said they appeared to be that species except for the rhizome, so presumed they belonged to *T. oppositipinna.* Holttum notes that the rhizomes of the Malayan specimens were missing.

* From the overgrown garden at Walkerburn Cottage.

I believe that the true species of *T. brunnea* as interpreted by Ching (Bull. Fan Mem. Inst. Bot. 6: 1936) has not yet been found in Malaya and perhaps this species should bear another name, if really different from *T. oppositipinna.*

Thelypteris beddomei (Bak.) Ching, (Holttum 240).

Cameron Highlands, Pahang, August 1956, c.5,000 feet. no. 2876. Previously known only from Maxwell's Hill where I found it in 1949, and where it is still common. In the Camerons it is fairly widespread and abundant where it does occur. It was growing above streams in open places and in semi-shade on the edges of light forest. In some places it formed stands so thick that there was little other growth. Old rotting fronds formed a deep loose layer (sometimes to 45 cm.) beneath the living fronds so that the latter had greatly elongated stipes (to 60 cm. long). The longest lamina measured was 40 cm. The fern seemed well established in this area just below Walkerburn Cottage, but when I returned in June 1958, grass and the shrub *Melastoma muticum* Ridl. had become tall and this fern had decreased quite considerably. It had become abundant however, on the more recently neglected lawn near the house, but the fronds were short.

In July 1958 I found *T. beddomei* growing between the tea bushes at Sungei Palas Tea Estate at c.5,500 feet. Sometimes it was so abundant that it covered the ground to the exclusion of other plants. It was also common on and above the roadsides here, and wherever the ground was sloping. As at Maxwell's Hill, the ferns were in full sun and the fronds were quite short, agreeing with the measurements given by Holttum.

I examined many fronds and found that, as Dr. Holttum notes, indusia were always present, and were evident even when the specimens were dry.

Ampelopteris prolifera (Retz.) Copel., (Holttum, 299).

Collected once in Malaya during last century by King's collector, on the Kinta River in Perak. In April 1956 I found one patch of this fern on the Kedah-Province Wellesley border where the old Bambong Lima bridge spans the Muda River. It was growing just below the road in alluvial soil, on flat ground which is frequently flooded by the river. It was scrambling over, and covering small bushes with quite a dense growth. Buds were produced five to six times along a lamina; these in turn became proliferous as they matured, so tracing the overall length was difficult. Stipes and

fronds were dark green when living. I found only two fronds bearing fertile pinnae and these were on tertiary fronds. *Athyrium esculentum* (Retz.) Copeland was very common nearby. In August 1958 I found *Ampelopteris* in Perak. It was alongside the Kinta River near Batu Gajah, possibly near the place of the original collection. For at least 150 yards along the river bank it was common to abundant, scrambling up small trees. Although the stipes and primary rachises were living, nearly all the pinnae, together with the secondary and tertiary fronds, were dead. No new nor fertile fronds were found. Here the river lies fifteen to twenty feet below the bank which is flat and composed of heavy soil, which was then very dry and hard. Apart from one small patch on the river bank, *Ampelopteris* was confined to a narrow band starting about ten feet from the bank edge and running parallel. This is where the trees occured, and beyond was cropped grass which I believe is frequently burnt back, and no ferns were found there. Other ferns growing amongst the *Ampelopteris* were *Athyrium esculentum* and *Cyclosorus aridus* (Don) Ching, both of which it slightly resembles in the field. In the following December fertile plants were found here, with mature sori on secondary fronds and very new sori on tertiary fronds.

The rootstock of *Ampelopteris* is very surface-rooted, being easily pulled out; the fronds when dry could be easily burnt. So perhaps as river edges are so often cultivated, this fern may have been eradicated from many areas. Otherwise it is difficult to understand why it is not so common as is *Athyrium esculentum* in these places. It is apparently seasonal as it is in other countries, dying back (in Perak) during the dry months between June and August. I have seen this fern with mature sori in December on riverbanks in west Siam. I have grown some plants by the Pinji River in Ipoh to observe their development. Herbarium specimens: 2794, 4090.

Microlepia puberula v.A.v.R., (Holttum p. 312).

Kepong and Sungei Buloh, Selangor. Collections made between 1951 and 1955. Herbarium specimens: 1382, 1482, 2333, 2393, 2541; from Ginting Simpah, Selangor in 1957, no. 3473.

Lindsaya cultrata (Willd.) Sw., (Holttum 328).

Near the 14th milestone, Cameron Highlands Road, Perak, September 1958, 1,000 feet; no. 4017. Locally frequent on mossy rocks in bed of large stream in jungle. Probably from plants swept down river from the mountains.

Leucostegia pallida (Mett.) Copel., (Holttum 353).

Although this fern has been seen recently by Sinclair, its habitat is of interest because of its doubtful native state. On a path alongside the water pipeline at about 2,400 feet on Maxwell's Hill in Perak, it is locally abundant, growing on the tops of large boulders. Here the fronds grow to at least the maximum length as given by Holttum; new fronds, which were produced in quantity in November, were bright pink. This immediate area, although clothed in tall forest has been cleared of a great deal of undergrowth, so that the boulders are only lightly shaded. Well away from the path the fern becomes less common, not occuring on the many similar boulders in the untouched forest where the light is poor. It grows however, on mossy tree trunks on, or just above the streamsides, and is quite widespread on this side of the hill at about this altitude. The fronds, although there were mature and old ones, were very much smaller than those from the first mentioned habitat.

I have looked for it several times in 1956, in similar places on Mt. Matang in Sarawak, from where it was formerly collected, but without success.

Blechnum orientale L., (Holttum p. 446).

A bi-pinnate to tri-pinnatifid form of the above fern was first seen on the forest edge by Girdle Road at Fraser's Hill at about 4,200 feet. Another plant was seen later on the roadside to the farm, but was very much smaller. In December 1956 I found this form was not uncommon locally near Batu Lintang Road in Kuching, Sarawak at sea level.

Only the Girdle Road plant showed transition fronds. There were very old fronds which were quite normal, others had deeply lobed pinnae and the newest (pink) fronds were bi-pinnate becoming almost tri-pinnate at their bases. When this plant was revisited sometime later, all the fronds were like the last mentioned ones, some measuring 145 cm. long. Unfortunately this plant was destroyed during roadside clearing operations. All plants examined had fertile fronds. It would make an attractive fern in cultivation. Specimen no. 2202.

Blechnum fraseri (A. Cunn.) Luerssen var. **Philippinense** Christ, Bull. Herb. Boiss. 6.149; van Alderwerelt van Rosenburgh, Malayan Ferns, 382. 1908.

Gunong Batu Brinchang, Cameron Highlands district of Pahang; 6,500 feet altitude, August 1956. Specimen no. 2920; February 1959, no. 4145. A living plant was sent to Kew in 1956.

Not previously collected in Malaya, but this variety is known from the Philippine Is., Borneo, Sumatra and New Guinea. *Blechnum*

fraseri belongs to the sub-genus *Lomaria* to which, in Malaya, only the mountain *B. vestitum* (Bl.) Kuhn, belongs.

Apart from the adult plants being larger, the Malayan specimens agree quite well with the descriptions I have seen of the variety, and with plants I subsequently saw on Mt. Kinabalu in British North Borneo. The following description is taken from Malayan plants from a series collected from one area on Brinchang.

Mature plants frequently (?) stoloniferous. *Rootstock* elongated into an erect caudex, the tallest measured being 235 cm. high, with a diameter of 5 cm. at approximately half way up the caudex, but more commonly 200 cm. by 6 cm., plants becoming fertile when caudex reached a height of 30 cm. Base of caudex thickened by a mass of old roots to 16 cm. or more through. Caudex or trunk rough, dark brown almost black, the greater part being scaly and rough from the remains of old stipe bases, but from the base extending upwards to c.90 cm. covered with close thin adventitious roots. Through these protrude scale-covered adventitious buds, 2–3 cm. long, which, near the trunk base had elongated into prop-roots 10 cm. and more long by about 1 cm. thick. *Stolons* 1 to 2 (or more?) from a parent plant, horizontal for at least 20 cm. before becoming erect and forming another plant which later becomes independent. Some of the thin adventitious roots from the upper side of the stolons elongate and growing downwards, anchor the plant. Caudex of new stoloniferous plant densely clothed with scales. *Scales* on caudex, stipe bases, and buds more or less similar, dark brown, thick with narrow elongated non-clathrate cells; length of scale to about 15 mm. and 2 mm. wide at base with subulate apex; edges entire with pale thin margins which are deciduous. *Fronds* bipinnatifid, whorled near the apex of the caudex and rather tufted at the crown. Fronds from shaded plants with thin elongated stipes, and laminae large, lax and dark green above, thin in texture; fronds in semi-shade or open places, nearly erect, shorter, upper surface yellowish-green, firm in texture. In both forms, upperside, shiny and glabrous; undersurface, dull, pale, sometimes almost glaucous and glabrous, except for sparse pale thin scales on rachises, costae and costules. Fronds dry olive brown above and greenish below. *Stipe* bases thickly clothed with dark spreading scales. *Sterile* fronds varying greatly in size according to habitat, up to 100 cm. long including stipe, by 35 cm. wide in shade specimens, but more commonly 56 cm. by 19 cm. Fronds widest about the middle, tapered to the apex. Base narrowed. Rachis winged throughout connecting pinnae, wing with triangular lobes, contiguous. Middle pinnae on large fronds to 17 cm. long

by 2·5 cm. wide but more commonly 10 cm. by 1·5 cm., deeply lobed with a long tapered apex which is entire for a length of 1 cm. or more at its tip. Upper pinnae ascending, gradually reduced in size to a lobed acuminate apex. Lower pinnae reflexed and reduced in size to about 7 cm. long on large fronds to 4 cm. on small fronds. Rachis wing continuing down the stipe gradually disappearing, leaving the triangular lobes as small auricles, until ceasing near the stipe base. Pinnae lobes entire, or toothed in shaded fronds, falcate, blunt or occasionally with very short pointed apices; lobes 2–4 mm. wide, cut to a costule wing 1·5 mm. wide, each lobe being separated by a hyaline membrane. Lobes becoming less deeply cut and decreasing in size towards the apex. *Fertile fronds* similar in shape to the sterile, but usually smaller and slightly contracted, to 60 cm. long by 20 cm. wide, with entire lobes gradually reduced in size for threequarters the length of a pinna, then rather suddenly contracted forming a long thin entire apical lobe, which is about 25 mm. long by 3 mm. wide. Sporangia covers the lower surface of the lobes, indusia are thin and light brown, just visible at maturity. Spores, anisopolar, pale, slightly verrucose, perispore folded. *Veins* translucent in thin fronds, but mostly obscured in those of firm texture. This description is taken from the former:—Two veins at each side of a costule base, springing from the costa, sometimes forked, ending within the lobe margin with a small hydathode. Veins springing from costule, to about 7 pairs, forked up to four times, more commonly three times, never reaching the margin. Forks of the lowest pairs occasionally anastomosing. Young, non-stoloniferous plants have short erect stocks, simply pinnate fronds with the bases of the bluntly toothed pinnae decurrent on the rachis.

On the left hand side below the road to the wireless station on Batu Brinchang, there is an almost vertical rock face about 150 feet from the mountain's summit. Here a long time ago there has been a landslide exposing the rock, and the earth from this slip has formed a shelf some 50 feet below the road. It was here in 1956, amongst mixed second growth of about 3 metres high, that the mature plants of *Blechnum fraseri* were found. It was then impossible to move through this vegetation, so an accurate count of this fern was not made, but twenty plants were noted. The largest, with trunks up to 200 cm. high, were concealed by a Melastomaceous shrub, by plants of *Cyathea latebrosa* (Wall.) Copel. var. *indusiata* Holtt., and by *Polygonum chinense* Linn. A few small infertile plants were growing in peaty soil on the road edge, and were only about 15 cm. high. Nearby on the cliff edge, in loose soil, were some slightly larger but still infertile plants; these were trunkless.

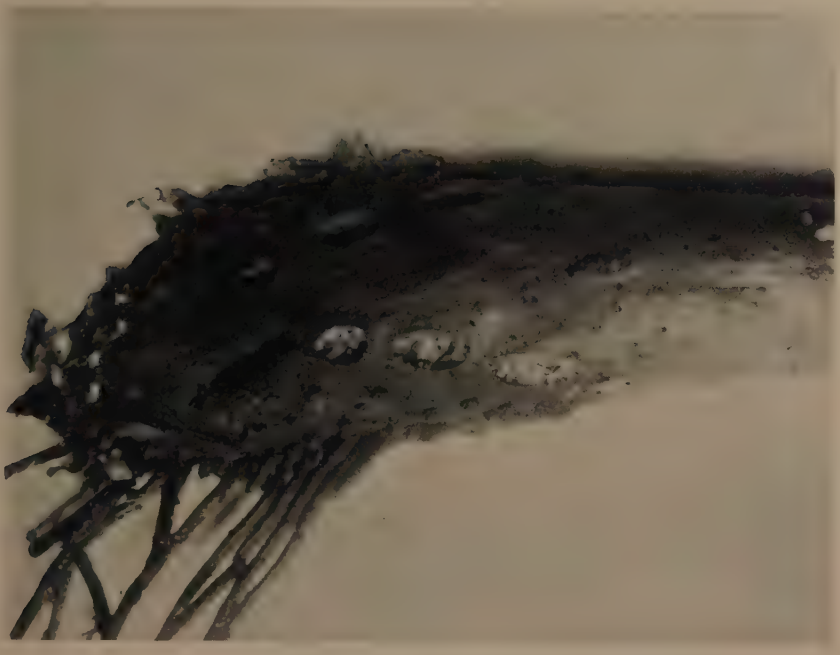
The two latter places were newly established, having been made during the road construction. On the cliff edge there were few other plants apart from a sedge and a dwarf *Thelypteris viscosa* (J. Sm.) Ching. In April 1958 all except one of the very small roadside plants of *Blechnum fraseri* had disappeared; the others on the cliff edge had grown considerably, but had not yet formed a trunk, nor were they fertile. The latter were almost concealed by the sedge, which had grown enormously but not yet flowered. In another area, in an open place a quarter of a mile away, and about 50 feet from the summit, there is another plant of this fern. It was of medium size, with a small trunk but was not fertile. This year (1959) I again descended to the earth shelf and found that the cover plants had grown so much it was now possible to crawl under them. *Blechnum fraseri* had certainly increased a great deal and within an area of approximately 35 by 25 metres, I counted 137 plants of this fern. More than 30 had definite trunks, some of these being more than 150 cm. high. The tallest specimens were in amongst the vegetation on the shelf, and were nearly all bearing fertile fronds, whereas the smaller and more sturdy specimens, which were fertile only when a trunk was developed, grew where there was only other sparse growth. In small pockets of earth on the rock face and in other quite open places, very young plants were exceedingly common.

The stoloniferous habit was found only amongst those specimens growing in full shade, where none of the young normally produced sporophytic plants were seen. Unfortunately this place is being used as a repository for old tins and boxes discarded from the wireless station above, so examination for stolons was difficult, and it has not been ascertained how common the habit is, in this variety of *Blechnum fraseri*. A new plant arising from a stolon which was measured, had a trunk 17 cm. high with a diameter of 1·5 cm., but had not produced any fronds, but already adventitious roots were strengthening its base.

In New Zealand *Blechnum fraseri* is a common fern of the Kauri (*Agathis australis* A. Cunn.) and other dry forests in the north, forming colonies but the caudex seldom exceeds 75 cm. in height.

Apart from the dendroid habit which makes this fern look like a diminutive *Cyathea,* it is an interesting addition to the Malayan fern list. The fronds show an intermediate state between simple and double pinnation, and the production of stolons, although a common feature in the type in New Zealand, may not have been recorded previously for the variety. The occasional anastomosis of

Cyathea excavata Holtt.; part of a pinna



Cyathea excavata Holtt.; stipe base showing excavations

Christiopteris tricuspis (Hook.) Christ.

Blechnum orientale L. Bipinnate form; one frond

var. *philippinense* Christ.

Blechnum fraseri (A. Cunn.) Luers.
var. *philippinense* Christ.
Sterile and fertile fronds

the veins is interesting although this may be more accidental, than indicative of development towards those Blechnaceae with regular anastomosis, for it seems to appear only in the large shade fronds.

The area where this Blechnum was found is fairly newly established as the growth of this fern and the other vegetation suggests, so perhaps there is another older established habitat here. In Borneo it grows in fairly open but short mossy forest, a similar kind being found on some of our higher mountains. On Batu Brinchang, however, a search for a different habitat of this fern is now practically impossible around this altitude. Below the road, every accessible place is being used for depositing rubbish. It is a great pity that such an interesting area is being ruined, as well as being rendered unsightly.

Elaphoglossum melanostichum (Bl.) Moore, (Holttum p. 455).

Maxwell's Hill, Perak; 24.1.1956, at 3,200 feet, no. 2711 was sent to Kew where Dr. Holttum kindly checked the specimen.

Previously known from Penang Hill. This fern occurs locally on Maxwell's Hill between 3–3,200 feet, on trunks of tall trees, usually on the forest edges in semi-shade. There were several plants on a tree about 60 cm. from the ground and in November 1955, nearly all of these had new fertile fronds.

Elaphoglossum decurrens (Desv.) Moore, (Holttum p. 458).

Summit of Gunong Brinchang, Pahang; 31.7.1956, 6,666 feet, no. 2911 sent to the British Museum and determined by the late Mr. Alston.

In Malaya this has been collected twice previously in the lowlands, but has however, been collected on Mt. Kinabalu in Borneo at "5,000 feet and more" (see Holttum).

Dryopteris subarborea (Bak.) C.Chr., (Holttum p. 491).

At Cameron Highlands this fern is terrestial (see Holttum 492), but at Fraser's Hill I have never found it so, but always as an epiphyte in tall primitive forest and usually hanging down from large clumps of *Asplenium nidus* Linn., apparently as Kunstler found it. At Maxwell's Hill it grows on mossy logs and sloping tree trunks in tall forest, but also on boulders on the exposed ridge near The Box, and here has small fronds.

Dryopteris sparsa (Don) O. Ktze., (Holttum p. 492).

Near Taman Sedia, Cameron Highlands, Pahang, at about 4,700 feet. In 1956 this fern was locally common on mossy rocks in the river and on moist earth banks in shady places. Plants were fertile.

Tectaria melanocaulon (Bl.) Copel. Ph. Journ. Sc. 2C, Bot., 6: 416. 1907; van Alderwerelt van Rosenburgh, Malayan Ferns 245. 1908 (Aspidium); Backer & Posthumus, Varenflora voor Java, 74.1939 (Tectaria melanocaula Copel.).

In tall forest near road to Cameron Highlands in Perak, at 26th milestone; 3,200 feet, June 1958, specimen no. 3985.

Not previously recorded for Malaya. Plants were found in one place but were very common here. They were on steeply sloping ground near a large rock face. Only one plant was fertile; it is hoped that later fuller field notes can be made.

The shining black stipes and rachises and very pale green fronds, distinguish this fern from any other Malayan *Tectaria*. Distribution: China, Malaysia.

Since writing the above, Dr. Holttum, who kindly compared my material at Kew, writes that the correct name should be **Tectaria melanocaulis** (Bl.) Copel.

Pleocnemia conjugata (Bl.) Presl. (Holttum, p. 534).

This fern has been collected twice in Malaya, near Malacca and at Baling in Kedah, the latter place suggesting that it may be a limestone fern. In April 1956 I went to Baling hoping to find it on the limestone hill of that name, but was unsuccessful. About four miles on the road to Kroh, however, I found it growing in a small quantity by the roadside, but not near any limestone. Twelve plants were seen which were nearly all young, but some had fronds to 170 cm. long, with stipes over 100 cm. long. There was only one plant with fertile fronds, and these showed the indusia clearly. Fronds were pale yellowish-green, but I have seen the same colour in fronds of *P. hemiteliiformis* (Racib.) Holtt. (normally much darker) when growing in sunny places at Fraser's Hill. In this area the *belukar* is frequently cut back for emergency reasons and possibly this has encouraged the growth of *P. conjugata* here. Apparently it requires only light shade, and was not being smothered by taller growth. Specimen no. 2793.

Cystopteris tenuisecta (Bl.) Mett., (Holttum p. 540).

This fern is worthy of note, for when it was first found in Malaya by Holttum in Cameron Highlands in 1936, it was apparently confined to a small area on a newly cut earth bank. When I saw it 11 years later, it was growing on the forest floor in the same area and was still rare, but the fronds were larger than those found by Holttum. In August 1956 I was unable to go back to the original place, but found that it was a common fern at about 5,000 feet

altitude. The favourite habitat seems to be on loose earth overhanging small streams in dark places, but here it was seldom fertile and the fronds were small. On a flat area just above normal water level above the stream, I found large plants which were fertile. The largest frond measured was 130 cm. long by 51 cm. wide, but were more common at about 80 by 30 cm. Fertile fronds were either very new or just mature, and no old fronds were seen. Since then I have found it at higher altitudes, up to 6,000 feet on Batu Brinchang. It appears now to be one of the common streamside ferns at 5–6,000 feet at Cameron Highlands.

Athyrium japonicum (Thbg.) Copeland, (Holttum p. 551).

Cameron Highlands, Pahang; July 1956; specimen no. 2904.

Previously collected from Maxwell's Hill in Perak and from Fraser's Hill in Pahang, so links the two localities. In 1956 there were several small plants of this fern at Robinson's Falls, growing in crevices on the large rocks in the river. Together with it were *Lindsaya cultrata* and *Dryopteris sparsa,* all of which must often be submerged. *Athyrium japonicum* had only one fertile frond. In 1958 I saw it in several places by and above streams in the vicinity of Kemunting and Sultan Abu Bakar roads, at about 5,000 feet in altitude. Large patches were on steep grassy banks just above the roadside near Sungei Palas Estate bungalow. Here it is well away from water, and is fairly exposed, and the fronds are uniformly small (about 18 cm. long).

Athyrium curtisii Holttum, (Holtt. p. 560).

Ampang, Selangor; June 1957; specimen no. 3436.

Athyrium velutinum (Holttum) Holttum, (Holtt. p. 567).

Cameron Highlands, Pahang, in the forest behind Walkerburn Cottage. Specimens no. 2936, 3937, 4022.

Only a few collections have been made of this fern. It appears to be not uncommon locally where the forest is dark, the ground sloping yet wet and rich in humus, but usually some distance above streams. I have found it at about the same elevations as are given by Holttum. In most plants that I have seen, the stock was not short, but usually quite stout and erect and sometimes was built up to 9 cm. in height, being supported by firm black roots. Living fronds are very dark green except when very young, then they are extremely pale. Fertile fronds always appear to be longer than the sterile and more deeply cut. They also have free pinnules for nearly half the length of each pinna. Pinnules are commonly 15 mm. long by 5 mm. wide (occasionally to 17 mm. long), but the sterile

fronds are about the same as given by Holttum. Indusia are a medium brown colour in living specimens.

Athyrium boryanum (Willd.) Tawaga, (Holtt. p. 567).*

Near streams by road to Cameron Highlands, Perak, at 22¾ milestone; 2,000 feet, August 1958; specimen no. 4006. A few plants with large rootstocks were found just above a stream on rocky ground at the forest edge. Although this fern has been collected in Perak previously, it has not been found in this State in recent years.

In February 1959 I came across a few plants of *Athyrium boryanum* near Trinkap, in the Cameron Highlands area, at c.4,000 feet altitude. The ferns were growing in the protection of a large rock in a fairly open place on the roadside. Fronds were large and fertile and all quite new.

This fern is certainly seasonal in its growth, fronds dying off at certain periods, so this may be the reason that in Malaya, it escaped the notice of collectors for about 50 years. In Perak there were no plants showing in June, and in August they were all new. At Fraser's Hill where I first saw *Athyrium boryanum* in 1952, my notes indicate that new fronds are produced earlier than in the Perak plants. During April, June and August I have recorded new fronds, but there were none at all in January when I searched for it in the same place.

A note should be made of the rootstock of *Athyrium boryanum*. Descriptions usually state that the rhizome is either erect or suberect, whereas in the Malayan form it is most ecrtainly creeping, with fronds borne closely together. The growing point occurs at one end of the longitudinal rhizome, which is usual in truly creeping rootstocks. The rhizome is thick and fleshy, and one which I have recently brought from Fraser's Hill for cultivation, measures 15 cm. long by 7 to 8 cm. through, and this is by no means the largest. About 2 cm. of the old stipe bases remain attached in a horizontal manner on the rhizome, each facing the growing-point. They remain green and fleshy until they eventually fall off. The oldest ends of large rhizomes are usually pitted with hollows where the stipe bases have been.

Athyrium amplissimum (Baker) Holttum, (Holttum p. 569).

Cameron Highlands, Pahang, near Walkerburn Cottage; c.5,000 feet altitude. Specimen nos. 2935, 3936. On light forest edge in fairly open places and in light shade. Previously found in Cameron

* Since preparing these notes, this species has been referred to a new genus, **Parathyrium** Holttum, Kew Bulletin, 3, 1958, p. 448.

Highlands, but only fronds with old sori had been seen and the presence of an indusium had not been determined. In August 1956 I found several plants with fertile fronds. On these I found no indusia, nor evidence that there had been any, and one of the fronds had young sori which ought to have shown them, had they been present, unless they fall long before maturity. Immature sporangia were pale greenish in colour, but were dark and almost black when mature.

No note, so far as I am aware, has been made of the mucilage which completely covers new fronds at the top of the stout erect stock. The mucilage was copious, and was present on all the plants I saw; there were no scales visible and I seldom found any on the new growth. There were, in fact very few broad scales present, the stipes having none, but as Holttum points out, the scaliness varies a great deal.

Athyrium dilatatum (Bl.) Milde, (Holttum p. 574).

Fraser's Hill, Pahang, at c.4,000 feet; specimen nos. 3325, 3328, 4197. On two occasions, a few plants were found growing in shady places in wet rocky ground, by pathsides in tall forest. One was below Girdle Road near Peninjau, and the other was below Lady Maxwell Road, both being near streams. In the third locality plants of this fern were abundant in a narrow wet ravine, in tall forest near the golf course, and so it is possible it is not uncommon in similar places throughout this area. The plant sizes agree with Holttum's measurements, but the pinnules were cut half way to the costae or less, never more. The colour of the living frond is dark green.

Coniogramme fraxinea (Don) Diels, (Holttum p. 589).

Near the road to Cameron Highlands, Perak, between 2,000 and 3,000 feet. On sides of rocky streams in tall forest, it is not uncommon here. A persistently variegated form, which I have also seen on the Taiping Hill, occurs frequently in the former locality.

Vittaria angustissima Holttum. (Holttum p. 610).

Cameron Highlands, Pahang; April 1958. On tree trunks; slopes of Gunong Kemunting, c.5,000 feet, specimen no. 3941; slopes of G. Jasar, c.5,400 feet, specimen no. 3928.

Vittaria flexuosa Fee, (Holttum p. 611).

In Malaya, the usual habitat for this fern is on trees in forest where conditions are constantly humid (see Holttum). In the Ginting Simpah forest on the Selangor side, there are many small to very large granite outcrops. These usually contain plants quite

different from those in the forest surrounding these cliffs. Here, between 700 and 2,000 feet, *V. scolopendrina* is usually to be found with its rootstock wedged in small crevices in the vertical rock. Usually the fronds are of normal size, others being fertile when scarcely 20 cm. long. These outcrops are seldom near streams and although sheltered by the tall forest trees, frequently become very dry.

Vittaria flexuosa Fee, (Holttum p. 611).

Penang Hill, Penang, c.2,500 feet; May 1956, specimen no. 2822. This plant agrees with the description of this species in Holttum. It was growing out of an epiphytic spongy root mass which was dead, but similar to that of an *Asplenium nidus* L. The Vittaria was intermixed with *V. ensiformis* Sw., from which it was easily distinguished. The fronds of *V. flexuosa* were pendulous, the longest being 90 cm., but none was wider than 5 mm., often narrower. The stipe was slender, the underside black and shiny and the upper surface black at the very base. There were new fronds with immature sori. When dry the frond edges become strongly incurled.

The root mass was in the fork of a small tree in short, rather sparse secondary growth on Western Hill and was fully exposed. Only a small portion was collected and so it is hoped that the remainder will survive in this locality.

Salvinia cucullata Roxb. ex Bory, (Holttum p. 621).

Kota Bharu, Kelantan, May 1957, specimen no. 3399. Previously collected from Kedah. I found that this little fern was not uncommon on the edges of the rice fields near the airfield at Kota Bharu. They were in small patches, to about 13 cm. long and were often mixed with *Azolla pinnata* R.Br. At this time of the year nearly all the fields were dry, but in corners where moisture remained, Salvinia was seen. I did not find any fertile plants.

I am grateful to Dr. R. E. Holttum for his continued help in comparing and identifying my material at Kew, and to the Director of the Singapore Botanic Gardens for checking nomenclature.

An interesting new record from the Malayan beach: Spilanthes urens Jacq., its synonymy and distribution

By J. H. Kern & C. G. G. J. van Steenis

Flora Malesiana Foundation, Leyden

In 1934 Mr. Corner collected on Jason Bay, Johore, a remarkable creeping Composite which at the time defeated identification. It grows as most beach plants with a horizontal, more or less subterranean stem, at the nodes giving off downward roots for anchorage and upward simple (lateral) stems (10–40 cm. high), each with a few pairs of opposite narrow leaves and a terminal, rather long-peduncled (5–15 cm.) head. The leaves are strictly opposite, 3-plinerved, 3–9½ by 0·4–1½ cm. The head consists entirely of tubular, white flowers and measures c. 1 cm. diameter. The achene is rather peculiar, being flattened elliptic, with one, less frequently two, awns on top and 2(–3) yellowish, rounded ridges (obviously corky), distinctly set off against the rather dark colour of the fruit itself.

It has now appeared that it had been referred in *Spilanthes*, a well-known genus of mostly erect, annual weeds. Bentham (1866) had referred a North Bornean specimen collected by Barber to the North Australian *S. anactina* F.v.M.; Martelli (1883) identified a specimen collected by Beccari in Sarawak as belonging to the American *S. urens* Jacq., and finally A. H. Moore (1907) had described a North Bornean specimen as a new endemic species, *S. chamaecaula* A. H. Moore.

The remarkable thing about the latter species appeared its rarity, its exacting habitat, and the fact that it seems to lack immediate relationships with any other Malaysian species in the infrageneric system of the monographer A. H. Moore. He placed it with the S. American *S. urens* Jacq. and some other species.

This circumstantial evidence raised our suspicion as it does not fit with the generally wide distribution of plants restricted to the tropical beach.

This led us to a closer examination of the characters A. H. Moore used in his revision to discriminate it from its allied species.

It appeared that *S. chamaecaula* was keyed out against *S. urens* on the strength of two characters, viz. the uniaristate achene (in the other species there are 2 bristles) and the corky swollen ridges which were said to be absent in the other species.

The first character broke down at once in the Bornean material, as in one head both 1- and 2-aristate achenes were found to occur.

The second character appeared at first sight satisfactory in our scant material at Leyden. But in a bunch of S. American material of *S. urens,* which we borrowed through the kindness of Dr. Lanjouw and Dr. Jonker from the Utrecht Herbarium, we found pertinent proof that in *S. urens,* which both in habit and in habitat agrees so very well with *S. chamaecaula,* in all heads containing mature achenes some of these are provided with the characteristic swollen corky ridges.

This induced us to re-examine a complete head of the scant Malaysian material and here we found to our satisfaction that besides the corky achenes there were in one single head also achenes without these ridges. Though it is possible that the ratio of achenes with and those without corky ridges differs slightly in Malaysian versus American material, it is useless for taxonomic distinction. It is rather astonishing that the presence of ridged achenes has hitherto been overlooked in *S. urens,* which is not a particularly rare plant in America. This demonstrated to us that for a good examination one must dissect an entire head; it is insufficient to pick just a few random achenes. In doing so we did not succeed in finding any regularity in the location of the corky achenes in the head.

We have come to the conclusion that Martelli, who referred the Bornean Beccari material to *S. urens,* was perfectly justified.

In the Old World a third species had been described from the islands in the Gulf of Carpentaria, viz. *S. anactina* F.v.M. Already Bentham, in the Flora Australiensis, had referred a Bornean collection of Barber (obviously in the Kew Herbarium) to it. F. von Mueller had described his species without having available ripe achenes. As the Queensland specimens agree perfectly in habit and habitat according to the description, we feel entirely at ease in reducing *S. anactina* also to the synonymy of *S. urens.* We feel the more confident as A. H. Moore merely distinguished *S. urens* from *S. anactina* by saying that it was found in the New World while *S. anactina* is from North Australia. There seems no doubt that this also represents the same species.

There is a fourth species which we feel should be critically re-examined, namely *S. pusilla* Hook. & Arn., from the New World. We have a strong suspicion that this is also conspecific with *S. urens.* The differences cited in Moore's key to exist between these two species appear very slight: the linear-spathulate leaves attributed to *S. pusilla* are quite common in *S. urens.*

It may seem remarkable that the localities in the Old World tropical beaches are so scattered and distant, but this is by no means uncommon in widely dispersed beach plants and is similarly encountered in mapping localities of *Scaevola plumieri, Ipomoea pes-caprae* ssp. *pes-caprae, Launaea sarmentosa, Suriana maritima, Digitaria longissima, Triumfetta procumbens,* etc.

The distribution of *S. urens* ranges from tropical and sub-tropical Central and South America to North Australia (Gulf of Carpentaria), and West Malaysia.

As far as we have ascertained within the scope of our examination the synonymy and the distribution in Malaysia run as follows:—

Spilanthes urens Jacquin, En. Syst. Pl. Carib. (1760) 28; Select. Stirp. Am. Hist. (1763) 214, t. 126, fig. 1; Martelli, Nuov. Giorn. Bot. Ital. 15 (1883) 296; Merrill, En. Born. (1921) 589.

?*Spilanthes pusilla* Hook. & Arn. in Journ. Bot., London 3 (1841) 317.

Spilanthes anactina F.v. Mueller, Fragm. Phyt. Austr. 5 (1865) 63; Bentham, Fl. Austr. 3 (1866) 541; Bailey, Queensl. Fl. 3 (1900) 863.

Spilanthes chamaecaula A. H. Moore, Proc. Am. Ac. Arts & Sc. 42 (1907) 528; Koster & Philipson, Blumea 6 (1950) 353.

Borneo. North Borneo: Burbidge (Gray); Barber (K). Sarawak: pr. Sibu, flowers white, leaves more or less fleshy, Beccari P.B. 1750 (Fi, L), June 1866.

Malay Peninsula, Johore: Sg. Tuenseh, Jason Bay, Corner S.F. 28459 (Sing, Bo, K, L, A), June 1934.

We hope that this little note will draw attention to this curious plant and stimulate collectors to find new localities.

A New Aroid from Sarawak

By C. X. Furtado, *Singapore.*

An anomalous aroid was noticed in the collections made three years ago in Sarawak by Mr. J. W. Purseglove, then the Director of the Botanic Gardens, Singapore. It belongs to the group of aroids which shed off the upper portion of the spathes before the fruits are formed on the enclosed spadices. Since the sheaths of the petioles of its leaves are broad and produce long, tongue-shaped free portions, the aroid could be a species of either Piptospatha or Microcasia. In their general appearance and the way they bend, the spathes resemble those of a Piptospatha, and the spadix is fertile up to the apex, a character mentioned for Piptospatha only and not for Microscasia which is described to have the spadix with a sterile apex or with an apex with sterile flowers. But in Purseglove's specimen the male flowers which occupy the upper two-thirds of the spadix have each two horns through the apical pores of which pollen is shed; and bicornulate stamens form a definitive character of a species of Microcasia. Hence the new species is assigned to this genus and named **Microcasia purseglovei** in honour of the collector.

Hitherto only two species of this genus were known, *M. elliptica* and *M. pygmaea,* both of which had helped to define the genus as having, among other things, a sterile apex to the spadix; but in view of the characters of the new species, the generic definition has to be altered to include also the species with fully fertile spadices.

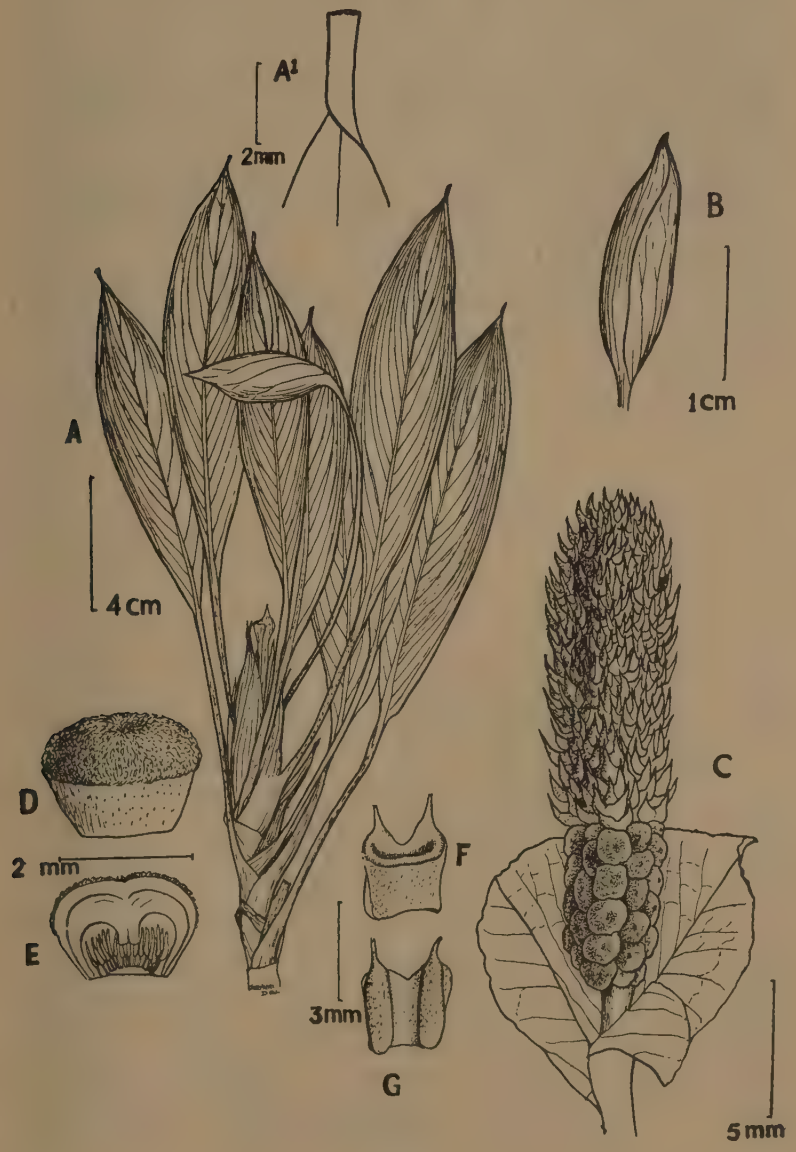
The two earlier described species were very tiny plants; but the new species is a very much larger plant in regard to the vegetative and reproductive parts.

Microcasia purseglovei Furtado **spec. nov.**

A duabus speciebus usque adhuc cognitis haec species stirpibus omnino majoribus, spadicibus ad apicem usque fertilibus differt.

Caudiculus elongatus, repens, in parte erecta 25–30 cm. altus. *Folia:* petioli tenues, laminis paulo breviores vel eis aequantes, 6–8 cm. longi; vagina papyracea, superne in partem liguliformiter solutam 2·5–3 cm. longam producta; lamina supra saturate viridis,

subtus albo-squamosa, ambitu elliptica, utrinque paulatim curvato-attenuata, apice in pseudo-tubulum abrupte convoluta, margine angustissime revoluta, 8–15 cm. longa, 2·5–3·5 cm. lata, nervis



primariis paucis cum secundariis adscendentibus, dein margine sub-parallelis, utrinque vix prominentibus praedita. *Pedunculus* petiolos superans, 12–18 cm. longus, apice curvatus, spatham horizontalem modo Piptospathae spp. ferens. *Spatha* circa 5 cm. longa, leviter convoluta, cum tubo brevi viridescente persistente quam lamina caduca albescens circa triplo breviore. *Spadix* quam spatha brevior, breviter stipitatus, circa 2·5 cm. longus, omnino fertilis; pars feminea basalis, parte mascula duplo brevior. *Ovarium* 1 mm. altum, circa duplo diametiens, stigmate depresso. *Stamina* bicornuta. *Bacca* ignota.

BORNEO: **Sarawak,** Tau, juxta flumen Mayeng dictum (Purseglove 5344, Holotypus in SING, isoholotypi in K, L, SAR.).

Microcasia purseglovei Furtado (Holotypus)

A, Planta. A1, Folii apex. B, Spatha. C, Spadix cum parte spathae. D, Ovarium. E, Ovarium longitudinaliter sectum. F, Stamen antice visum. G, Stamen postice visum.

Some New or Noteworthy Species of Malaysia

By C. X. Furtado

While arranging the material of the genus Ardisia in the Singapore Herbarium, some new species or new records were noticed, while others had to be excluded from the genus. The status of some of these will have to be settled by comparing the types; but the following notes are published here in order either to clarify some confusions that existed in the herbarium and also in the recently published literature on the subject, or to give a status to some of the names that have been adopted in the Singapore herbarium where the types and other specimens cited in this paper are preserved. As originally published by Mez, the sections mentioned here were subgenera, but they have been treated as Sections by Merrill and others, an arrangement that seems to be more in accord with the present concepts of nomenclature.

ARDISIA Swartz

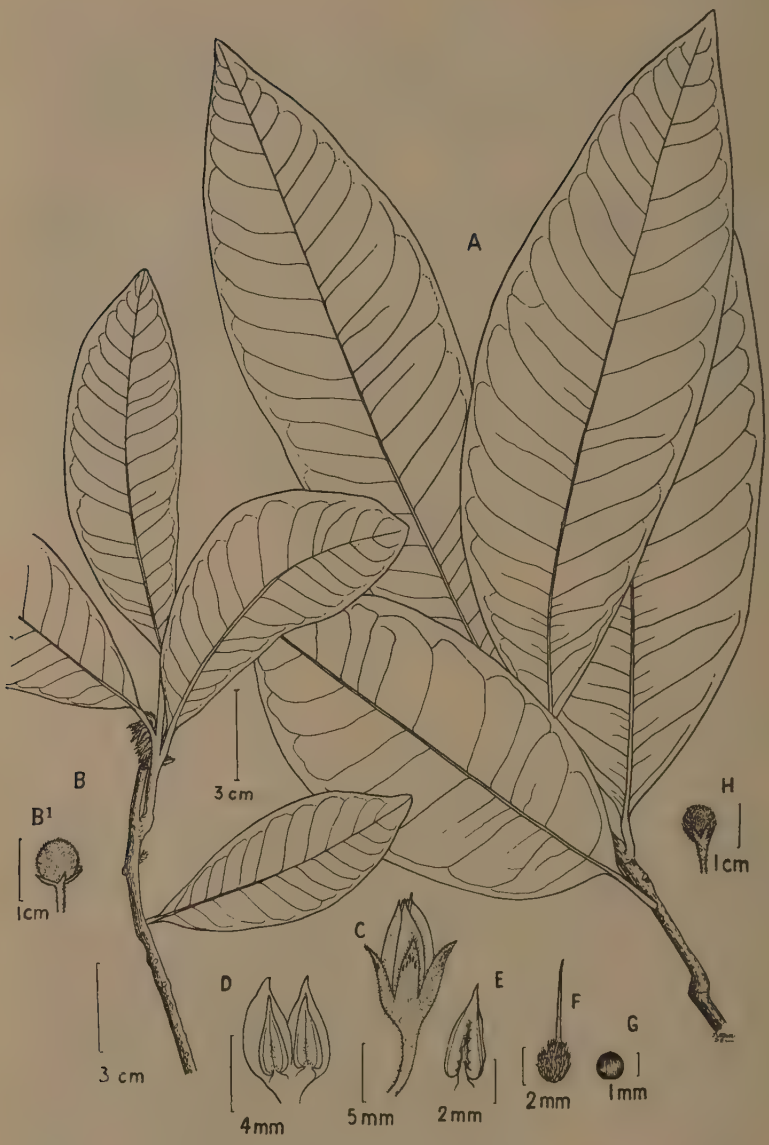
Section Pimelandra Mez.

1. **Ardisia ferox** Furtado **sp. nov.**

A. pachysandra (Wall.) Mez *sensu* Ridl., Fl. Mal. Pen. II (1923) 240 p.p.

Ab A. fuliginosa, *cui affinissima, innovationibus deciduo hirsutis; foliis utrinque glaberrimis, punctulis majoribus margines versus sitis, vix reticulatis; inflorescentiis valde abbreviatis, omnino hirsutis; sepalis liguliformibus, hirsutis, basin versus fere ¼-connatis; ovariis baccisque longe pilosis sat dissimillima.*

Ramuli validiusculi, novelli dense ferrugineo pilosi, adulteriores mox glabrati. *Folia* petiolis hirsutis vel glabris, 10–12 mm. longis, in ramulos lineatim decurrentibus stipitata, coriacea, elliptica, 12–25 cm. longa, 4–8·5 cm. lata, utrinque glaberrima, nitida, nervis lateralibus utrinsecus 14–16 patentibus, prope margines arcuatim ascendentibus et inter se unitis praedita, apice obtusa, basin versus oblique angustata, immo paulo decurrentia. *Inflorescentia* valde abbreviata, flores hirsutos gerens. *Sepala* liguliformia, hirsuta, basi fere ¼-unita, haud imbricata. *Petala* sepalis longiora, extus hirsuta, ovata, acuta. *Stamina* ovato-acuta, petalis breviora. *Ovarium* valde hirsutum; ovula glabra, verticaliter corrugata. *Bacca* pisiformis, ferrugineo-pilosa, circa 5 mm. in diam.



Ardisia ferox Furtado (A–B1: Holotypus; C–H: Mat s.n.)

A, Ramulus cum foliis majoribus. B, Ramulus cum infructescentiis. B_1, Fructus cum calyce. C, Flos ante anthesin. D, Petala duo postice visa. E, Stamen antice visum. F, Ovarium. G, Placenta. H, Fructus juvenilis.

MALAYA: Johore, Gunong Pulai (Nur & Kiah 7,778—Holotypus; Ridley 12,189; Mat s.n. in 1892): Omnia specimina in herbario Singaporensi conservata.

2. **Ardisia fuliginosa** Bl., Bijdr. (1826) 692; Mez in Engl. Pflanzenr. IV 236 = Heft 9 (1902) 99.

A. tomentosa Presl., Rel. Haenk. II (1835) 66: Mez in Engl. Pflanzenr. IV, 236 = Heft 9 (1902) 100; Merrill, Enum. Philipp Pl. III (1923) 265. **syn. nov.**

A. disticha A. DC., Prodr. VIII (1844) 129.

SUMATRA: Atjeh (v. Steenis 6,186); Takigeum (W. & C. Bangham 726); loc. incert. (Forbes 2,142).

BORNEO: North Borneo, Marudu Kudat (Austin A 1,191); Tawao (Elmer 20,462). **Sarawak,** Rejang (Haviland 3,029).

JAVA: Besuki (Steenis 10,826).

PHILIPPINES: loc. incert. (Cuming 849, isoholotypus of *A. disticha*); Jamindan (Ramos & Edano 30,999); Mt. St. Isidoro (Fenix 30,008); Angat (Ramos & Edano 34,062), etc.

There is a good deal of variation in the tomentum of the leaves as well as in the branching of inflorescences.

3. **Ardisia korthalsiana** Scheff., Comm. Myrs. Arch. Ind. (1867) 57; Mez in Engl. Pflanzenr. IV 236 = Heft 9 (1902) 99.

A. teysmanniana Scheff. *sensu* Ridl., Fl. Mal. Pen. II (1923) 240 p.p.

MALAYA: Trengganu (Moysey & Kiah 33,384). **Pahang,** Gunong Tapis (Symington & Kiah 28,825); Sungei Tahan (Kiah s.n.); Sungei Teku (Kiah 31,709); Wray's Camp on Tahan (Ridley 16,241). **Malacca,** loc. incert (Alvins 1755, as *Kayu Segankan* & 582 as *Meddang Panjang*); Bukit Bruang (Derry 456, as *Tambang Sisir*); Lubok Kadondong (Ridley s.n. on 13–VI–1892); Bukit Besar on Mt. Ophir (Ridley in Dec. 1898); Selandor (Alvins 673 = 251, as *Pokok Lagan*). **Johore,** Gunong Belumut (Holttum 10,693 & 10,788).

SUMATRA: West Indragiri in Taluk region (Meijer 4,077 as *Balam Siram*).

ANAMBA ISLANDS: North Jemaja near Padang (Henderson 20,392).

There is a good deal of variation in the specimens. Some (e.g. Moysey & Kiah 33,384 & Kiah 31,709) are practically glabrous and shining in the lower surface with a few minute hairs on the

midrib and with minutely dense reticulations and black glands on the upper surface. The Johore specimens have glabrous and more coriaceous leaves, and though the leaves are similar, black glands are conspicuous on their upper surface in Holttum 10,788 but not in Holttum 10,693. Many other specimens have leaves which are more pilose beneath.

This is the first record in Malaya.

4. **Ardisia pachysandra** (Wall.) Mez in Engl. Pflanzenr IV 236 = Heft 9 (1902) 97 fig. 14 A–E, partim; King et Gamble, Mat. Fl. Mal. Pen. IV (1905) 331; Ridl., Fl. Mal. Pen. II (1923) 240 p.p.

MALAYA: Kedah, Gunong Jerai=Kedah Peak (Ridley in VI —1893); Gunong Bintang (Haniff 21,118). **Perak,** Piah (Penak 39,221); Pulau Rumbia (Seimund on 28–III–1926); Tapah Ridley 14,062). **Penang,** Telok Bahang (Curtis = 1156, as *Limpanan*); Waterfall (Curtis 3,737; Nur 1,225); Government Hill (Curtis = 1156; Ridley = Curtis 1156); Penara Bukit (Curtis 1156); loc. incert. (Curtis ? 3181 & 3164). **Selangor,** Weld Hill (Rahman, Tree 334). **Johore,** Gunong Panti (Ridley in Dec. 1897); Sungei Kayu (Corner 29,197).

BANGKA: (Anta 212, & 685 & 966).

ANAMBA ISLANDS: near Terempak in Siantan (Henderson 20,186); Gunong Ranai in Bunguran (v. Steenis 1287); Padang Leting.

JAVA: Tjibodas (Yates 2,924); Gunong Gendero (Kanta 236); Besoeki (Buwalda 7,255 and 7,377).

This species is listed here to show the range of distribution. Usually non-Malayan specimens of this species are distributed unnamed or as *A. fuliginosa.*

There is a good deal of variation in this species, in regard to the size of peduncle and the sepals and in the distribution of tomentum and glands on the leaves; but the ovaries are glabrous. Some Javanese specimens can be mistaken for *A. fuliginosa* if ovaries are not examined.

Ridley 176 & 2,800[a] which were cited here by Mez, have been transferred to *A. teysmanniana.*

5. **Ardisia teysmanniana** Scheff in Tijdschr. Nederl. XXXI (1870) 368; Mez in Engl. Pflanzenr IV 236 = Heft 9 (1902) 97; King et Gamble, Mat. Fl. Mal. Pen. IV (1905) 122; Ridl., Fl. Mal. Pen. II (1923) 241 p.p.
A. pachysandra Mez op. cit. p. 97 partim.

MALAYA: Perak? loc. incert (Ridley 462). **Malacca,** Sungei Udang (Derry 1,143 as *Medang Ketanak*). **Johore,** Sungei Sedili (Ngadiman 36,894). **Singapore,** Sembawang (Ridley 5,573); Chan Chu Kang (Ridley 6,788); Changi (Ridley 2,800; 5652 & 176; Goodenough 2,800); Bukit Timah (Ridley 2,800[a]; Corner sn.; Chew 10).

Ridley 176 & 2800[a] were cited by Mez under *A. pachysandra.*

Section Akosmos Mez

6. **Ardisia laevigata** Bl., Bijdr. (1826) 690.

MALAYA: Pahang, Cameron Highlands, 1500–1700 m. alt. (Henderson 18,022; Symington 21,016; Osman 20,810; Holttum 24,985).

JAVA: alt. 1500–2400 m.: Pasoeroea (N.-Ind. Flor. Serv. No. 7, 143); Tjibodas (Sapun 239; Burkill 8,265).

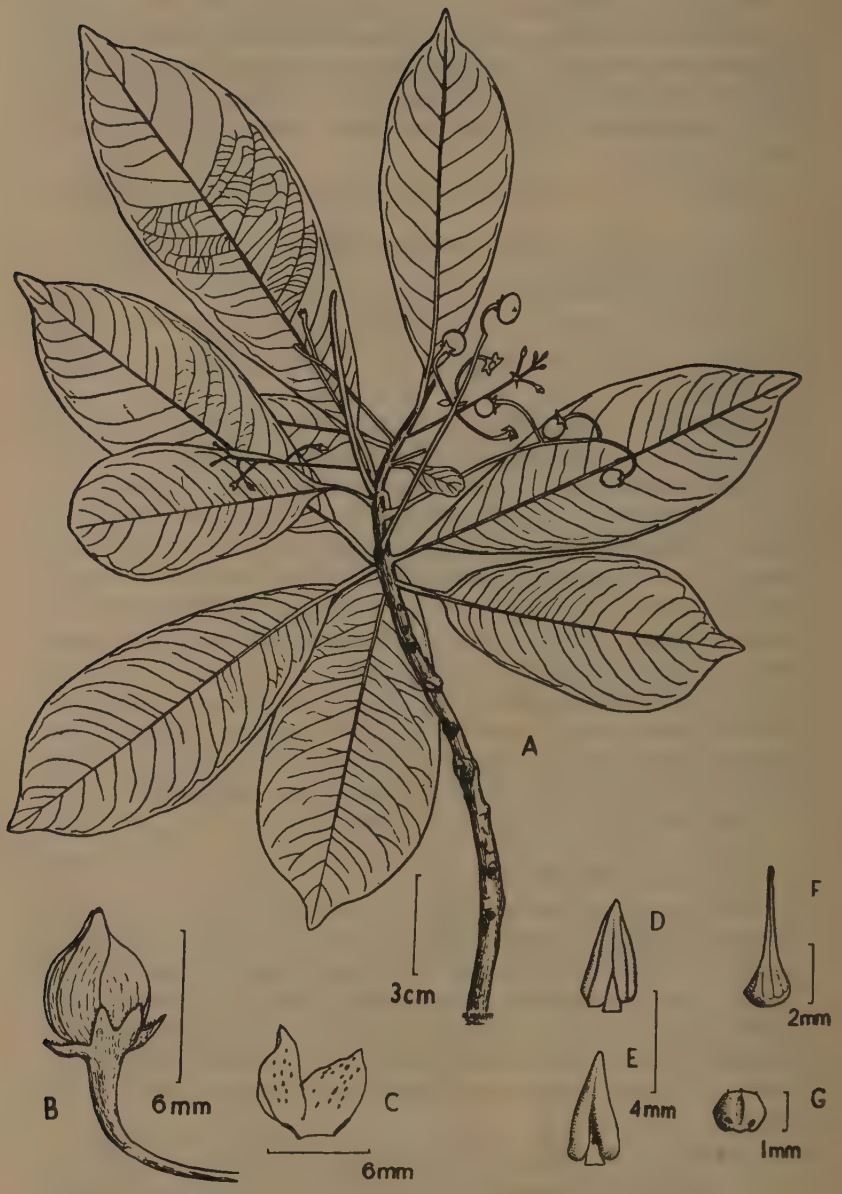
This is a first record for this species outside Java. Burkill notes that the flowers are downwardly directed and pinkish white, leaf-stalks crimson and berries round greenish, all found on the same plant at the same time. Henderson records as follows: "Small, straggling tree in swampy places. Ripe fruit red." Symington's notes suggest that the tree is 15 ft. tall and the fruit is green at first but turns red later and finally black.

The Malayan specimens show more coriaceous leaves and broader sepals which are somewhat ciliolate along margins. But no material differences are noticed to separate these from the Javan forms. Gland dots on sepals and petals may be found in the Malayan as well as the Javan specimens.

7. **Ardisia praetermissa** Furtado **sp. nov.**

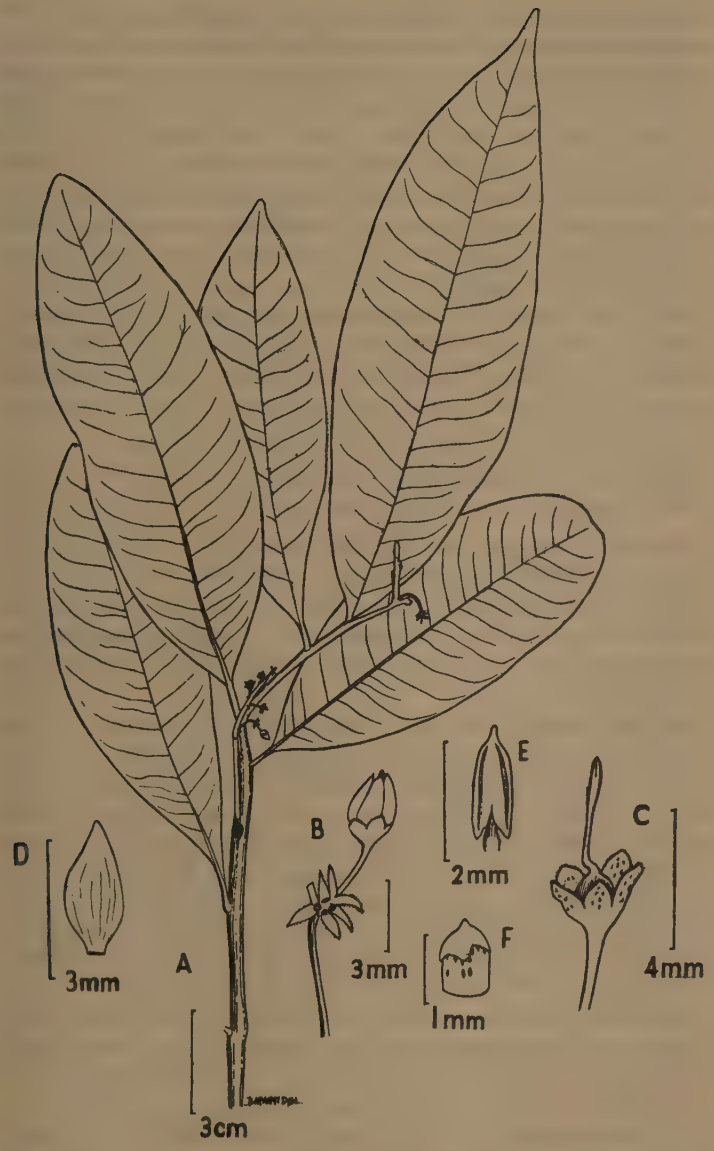
Inter species Akosmosis *insignis: innovationibus lepidotis; foliis coriaceis, ellipticis, primo utrinque serius subtus tantum lepidotis, margine integerrimis, laxe reticulatis; inflorescentiis quam petioli 1·5–2·5 cm. longi altioribus, in ramulos primarios apice floribus pedicellatis congestis et bracteolis ciliolatis fere linearibus praeditos divisis; sepalis punctulatis ciliolatis quam petala valde brevioribus, basi ½–1/3–unitis; staminibus petala brevioribus apice subito acuminatis.*

Frutex circa bimetralis, in innovationibus lepidotus. *Folia* elliptica, coriacea, 12–18 cm. longa, 4–5·5 cm. lata, basin versus sensim vel rotundato attenuata, in petiolos 1–2·5 cm. longos, lepidotos, supra canaliculatos, margine scariosos paulo decurrentia, apice



Ardisia laevigata Bl. *(Holttum 24,985)*

A, Habitus. B, Floris alabastrum. C, Petala duo antice visa. D, Stamen postice visum. E, Ibid antice visum. F, Ovarium. G, Placenta.



Ardisia praetermissa Furtado *(Alvins 342—Holotypus)*

A, Habitus. B, Inflorescentiae ramulus cum bracteolis floreque. C, Flos petalis desumptis, ut stylus apice bifidus (?) appareat. D, Petalum. E, Stamen postice visum. F, Placenta nonnihil tabida.

obtusa vel acuminata, primo utrinque dein subtus tantum lepidota, supra veridescentia et in costa mediana valde sulcata, patente nervosa, laxe reticulata, margine integerrima, punctulis multis minutis subtus fere inconspicuis supra saepe manifestis aucta. *Inflorescentia* axillaris, unica completa visa, circa 5 cm. longa, axi lepidota in 7–8 ramulos ad 12 mm. usque longos, apice umbellatim vel subumbellatim floriferentes, bracteolis persistentibus, circa 1–2 mm. longis, linearibus vel lineari-lanceolatis, margine valde ciliolatis praeditos divisa. *Flores* pedicellis 3–4 mm. longis deciduo lepitodulis suffulti, ante anthesin stylis exsertis aucti, in alabastro circa 5 mm. longi. *Sepala* extus minute lepidota, basi ½-unita, in lobis ovata vel ovato-oblonga, apice acuta, dorso sparse punctulata, margine albescentia ciliolataque, circa 2 mm. alta. *Petala* sepalis subtriplo longiora, apice acuta vel obtusa, fere ad basin libera. *Ovarium* glabrum; stylus tortuosus, apice bilobatus?

MALAYA: Malacca, Selandor (Alvins 679=342, nom. vern. *Pokoh Pelandok Payah*—Holotypus in SING.).

This specimen was collected by Alvins on Jan. 30, 1885, and was assigned in our herbarium first to *A. crassa* and then to *A. colorata*. According to Alvins, this plant is common in swamps and grows to a height of 6–7 ft. The label was originally numbered 679, and subsequently it was numbered 342, but the original number has not been cancelled.

The inflorescence is axillary bearing very short branches. In the axis of the only one complete inflorescence available, there are marks of fallen off branches and below its base a scar of the axillant leaf. Only 3 flowers were available, all badly preserved. The style of the one examined bore a mark at the apex as if it was bifid. The ovary and the placenta showed marks of disintegration. The petals seem to be free nearly to base.

8. **Ardisia singaporensis** Ridl. in Journ. Roy. Asiat. Soc. Str. Br. 79 (1918) 92 et Fl. Mal. Pen II (1923) 251.

MALAYA: Singapore, Pulau Ubin (Ridley 2,816, Isosyntype and s.n. in 1891; Goodenough on 3–III–1893); Changi Road (Goodenough 2,833, Isosyntype); Changi (Goodenough 2,814): All specimens cited are in Singapore herbarium.

The inflorescences are borne usually in the axils of the leaves near the apex, but sometimes also of the leaves much below the apex. The flowers are borne in umbels at the end of primary or secondary branches of the inflorescence axis, rarely at the end of the unbranched axis itself.

This species should be placed in Section AKOSMOS and is in no way related to *A. miqueliana*. Specimens of the species were distributed as *A. ferruginea* var. *glabrata* and some were named in Singapore herb. as *A. tuberculata*.

Section STYLARDISIA Mez

9. **Ardisia miqueliana** Scheff. in Tijdschr. Ned. Ind. XXXI (1870) 367 et in Flora LIII (1870) 253; Mez in Engl. Pflanzenr. IV 236 = Heft 9 (1902) 115.

A. ferruginea Mez op. cit. (1902) 108; King et Gamble, Mat. Fl. Mal. Pen. IX (1905) 325; Ridl., Fl. Mal. Pen. II (1923) 250, non *A. ferruginea* H.B. & K. (1818)—**Syn. nov.**

A. rudis Sinclair in Gard. Bull. Sing. XV (1956) 24—**Syn. nov.**

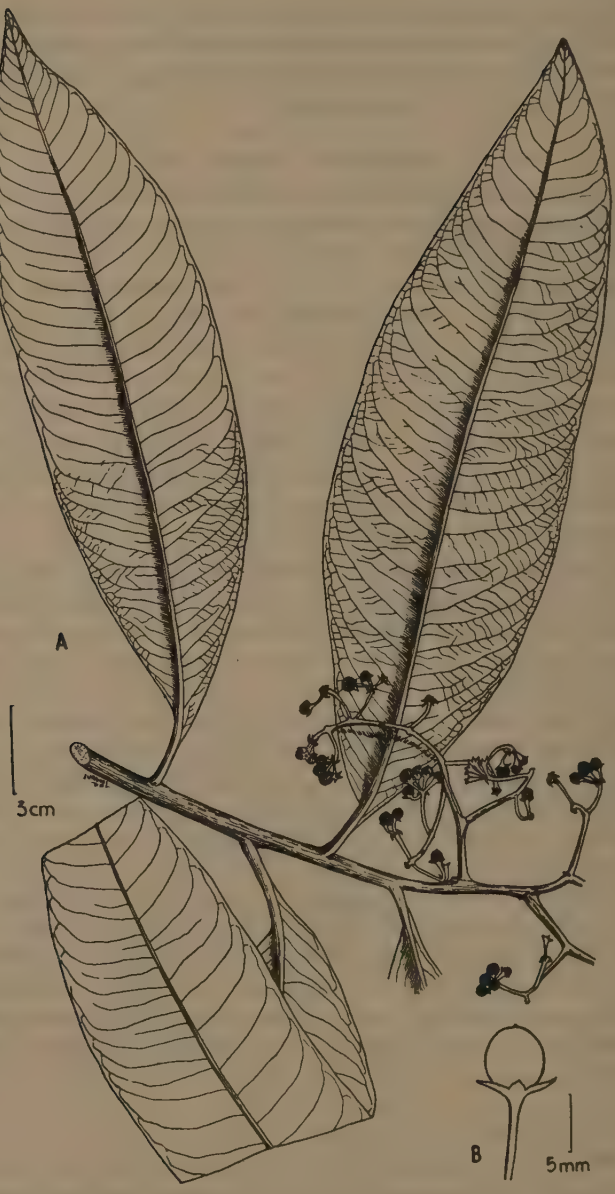
MALAYA: Johore, Kampong Simpai (Lake & Kelsall, 4032, Isoholotypus of *A. ferruginea* in Herb. Sing.); Kluang (Holttum 9,356); Bukit Lenggor (Holttum 24,927); Sungei Kayu (Corner, 32,236; Kiah 32,076); Gunong Belumut (Holttum 10,621). **Singapore,** Nee Soon (Sinclair 40,278).

Already King & Gamble had noted that the leaves were exactly like those of *A. miqueliana*. The specimens collected by Lake & Kelsall were apparently from a plant just beginning to flower and so the fact that the inflorescence was actually terminal became obscured due to the well developed lateral branches at the base of the terminal panicle. I do not know the reasons that led Ridley to transfer *A. ferruginea* Mez from Section AKOSMOS to Section CRISPARDISIA. But there is no doubt that the species should be placed in Section STYLARDISIA, the few well developed flowers showing their styles well above the petals of the unopened flowers.

The holotype of *A. miqueliana* was from Bangka. Corner notes that the plant is 20 ft. tall with monopodial side branches and with silvery grey pustular bark with small lenticels: Twigs, petioles and underside of leaves old hairy. Inflorescence hanging at the end of the side branches. Pedicels purplish upwards and at top. Bracts green. Sepals greenish white, but magenta at base. Petals white with a magenta spot at base. Filaments magenta; connective greenish, anther yellow.

10. **Ardisia nurii** Furtado **spec. nov.**

Ab A. crassa, *cui valde affinis, foliis rigidioribus, nervis lateralibus reticulationibusque subtus validioribus, inflorescentiis omnino minus tomentosis, floribus gracilioribus, sepalis fructibusque minoribus haec species facile distinguenda. Ab* A. colorata *var.* colorata,



Ardisia nurii Furtado *(Nur 10,511—Holotypus)*
A, Ramulus fructiferus. B, Fructus.

quacum confusa, foliis coriaceis nitidisque, bracteolis flores axillantibus persistentibus, floribus majoribus robustioribusque sat distincta.

Arbusculus 3–4 metralis, ramulos robustos gerens. *Folia* oblongo-elliptica, apice acuminata, basi oblique acuta vel oblique decurrentia, vel rotundato-acuta, 18–25 cm. longa, 6–7 cm. lata, utrinque vel supra tantum nitida, subtus brunnescentia et lepidibus minutis deciduis praedita, glandulis haud visibilibus, nervis lateralibus primariis pluribus subtus valde prominentibus supra immersis, in nervum intramarginalem interruptum conjunctis, nervis secundariis multo brevioribus, reticulationibus densis paulo prominulis percursa, petiolis 2–3 cm. longis stipitata. *Inflorescentia* apicalis, pyramidalis, in ramulos arcuatos bi- vel tri-pinnatim divisa, ferrugineo lepidota. *Bracteolae* minutae, linguiformes, ferrugineo-lepidotae, margine ciliatae, pedunculi apice fructiferi persistentes. *Bacca* subglobosa, circa 4 mm. longa, apice compressiuscula, nigra, laevis; pedicelli umbellati, dense lepidoti, 6–10 mm. longi; sepala ovato triangularia, extus dense lepidota, margine flavescentia ciliata, dorso atro-pustulosa, basi breviter tubulosa.

MALAYA: Pahang, Fraser's Hill, alt. 1300–1500 m. (Nur 10,551—Holotypus; Burkill & Holttum 8,514 and s.n. = 8,514; Henderson 11,232). Omnia specimina in Herb. SING. conservata.

This appears to be localised to Fraser's Hill. The duplicates of the numbers were distributed to other herbaria under *A. colorata* from which this species is distinguished by its coriaceous and shining leaves, persistent bracteoles at the base of the fruits and larger and more robust fruiting calyces. The species appear more close to *A. crassa* which, however, bears much larger flowers and fruits, thicker tomentum on calyces, and less prominent veins and reticulations on the lower surface of the leaves.

11. **Ardisia sessilis** Scheff., Comm. Myrs. Arch. Ind. (1867) 69; Mez in Engl., Pflanzenr. IV. 236 = Heft 9 (1902) 115.

MALAYA: Singapore, Seletar (Ridley s.n. in 1894); Chan Chu Kang (Ridley 3,653 & 3,844).

BORNEO: North Borneo, Tawao (Elmer 21,404 & 21,424). **East Borneo,** Pelawan Besar (Act. 745).

This material has been named on the basis of the description given by Mez, and requires verification by comparing with the type. The Singapore specimens were quoted by Ridley under *A. crassa* in Fl. Mal. Pen. II (1923) 249, while Elmer's collections were referred doubtfully to *A. fortis* Mez by Merrill in Univ. Calif. Publ., Bot. XV (1929) 234.

Ardisia breviramea Merr. (Elmer 20,425—Isotypus)

A, Ramulus floriferus. B, Flos. B1, Ibid sepalo desumpto ut petala fere libera appareant. C, Petala duo cum staminibus postice visa. D, Stamina calyce corollaque desumptis. E, Stamen postice visum. F, Calyx. F, Ovarium. H, Placenta.

The flowers are practically sessile and bear ovate, entire, acute sepals which are ciliate in the margins. The primary nerves tend to join and form an intramarginal nerve on the leaves.

Section Acrardisia Mez

12. **Ardisia breviramea** Merr. in Univ. Calif. Publ. Bot. XV (1929) 235.

NORTH BORNEO: Tawao (Elmer 20,425—Isoholotype in SING.).

Since the inflorescences are apical (a fact also noted by the author of the species) and since the styles do not protrude just before the flowers open, the species cannot be placed in the sections Stylardisia or Akosmos to which Merrill had referred doubtfully. He had not seen the flowering specimens. Since the Singapore specimen is the duplicate of the holotype and bears flowers, it has been illustrated here as a help in understanding this species which was described from a fruiting specimen only. As in *A. praetermissa,* the petals are free almost to the base.

13. **Ardisia goodenoughii** Furtado **sp. nov.**

Ab A. divergente, *cui valde affinis, haec species foliis majoribus conspicue pustulatissimis, nervis lateralibus primariis pluribus, sepalis valde glandulosis differt. Ab* A. polyacte, *cui similis, petiolis longioribus, foliorum glandulis pluribus conspicuioribus, floribus minoribus paucioribusque in axi distanter sitis, petalis haud acuminatissimis facile distinguitur.*

Frutex circa 3 m. altus. *Folia* oblongo- vel lanceolato-elliptica, basi in petiolos 6–10 mm. longos corrugato-decurrentia, 12–20 cm. longa, 5–9 cm. lata, interdum ad 30 cm. usque longa et 11 cm. lata, omnino praecipue secus margines valde glandulosa, glandulis juvenilibus atribus vetustioribus pustulosis, densissime reticulata. *Inflorescentia* apicalis, in ramos floribus pseudo-umbellatim praeditos divisa, foliis fere aequalis vel brevior. *Flores* pedicellis 10–15 mm. longis suffulti, deciduo-puberuli. *Sepala* ovata, apice rotundata, basi imbricata, margine minute ciliata, dorso valde pustulata. *Petala* extus parce pustulata, sepalis fere triplo longiora, ovata, apice acuta vel breviter acuminata. *Stamina* petalis breviora. *Stylus* ex alabastro ante anthesin haud exsertus.

MALAYA: Kemaman, Ulu Kajang (Corner 30, 432); Bukit Kajang (Corner s.n. on 30–X–1935); Ulu Bendong (Corner 30,046 & 30,099). **Selangor,** Bukit Tangkol in Ulu Langat (Millard 1,380 as *Kayu Bilal*); Sungei Lalang in Kajang (Symington

Ardisia goodenoughii Furtado *(A, Strugnell 12,716; B–H, holotypus)*

A, Ramulus fructiferus. B, Ramulus floriferus. C, Flos. D, Corolla. E, Stamen postice visum. F, Stamen antice visum. G, Ovarium. H, Placenta.

22,681); Ampang (Strugnell 12,716); Kuala Lumpur (Goodenough 41, Comm. sub numero Ridleyano 10,481, holotypus in SING); Ginting Bidai (Ridley as *Mata Ayam*); Seminyih (Hume 8,371 & 8,401); Ginting Simpah (Hume 9,525). (Omnia specimina in Herb. Sing. conservata).

BORNEO: Sandakan (Cuadra A2,221 SING.).

The Kemaman and the Bornean specimens represent either material taken from young, vigorously growing shoots or a variety of the type form. The leaves are somewhat thinner in structure and the glands are largely not pustulose. In the Kemaman specimens the inflorescence is very much more slender in its axis, branches and pedicels, and the leaves are also much larger.

Section TINUS (Burm.) Mez

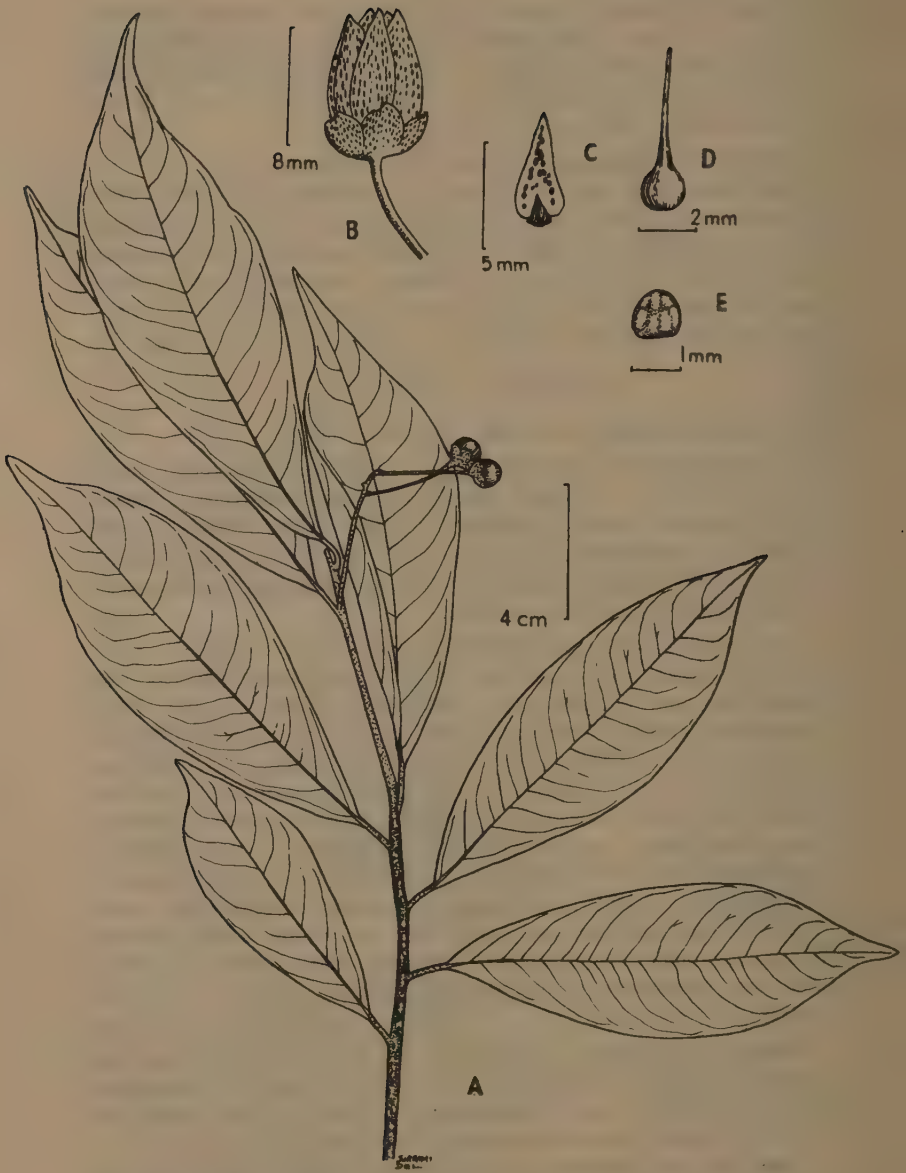
14. **Ardisia gambleana** Furtado **sp. nov.**

A. rhyncophyllae *affinissima, sed petiolis longioribus, foliis obovato-ellipticis, utrinque dense reticulatis, nervis lateralibus prope marginem arcuatim porrectis paulatim evanescentibus, haud in lineam conspicuam intramarginalem conjunctis, inflorescentiis sueto tri- vel bifloris, sepalis ovato-rotundis margine plerumque emarginatis nudisque sat distincta.*

Frutex circa trimetralis. *Folia* chartacea, obovato-elliptica, apice eleganter acuminata, basin versus cuneata, novella lepidibus minutissimis obscuris deciduis tecta, dein glabra, glandulis atris dense punctulosa, nervis primariis utrinsecus 7–10, prope marginem arcuatim porrectis praedita. *Inflorescentia* axillaris, tri- vel biflora, pedunculo 2–3 cm. longo, pedicellis fere aequilongo praedita, omnino glandulosa. *Sepala* basi breviter connata, valde imbricata, dense glandulosa, margine flavescentia nudaque, ovato-rotundata, emarginata. *Petala* sepalis fere triplo longiora, ovata, apicem versus sensim vel interdum abrupte attenuata, summo acuta, extus dense punctulata. *Stamina* petalis breviora, ovata, acuta, postice glandulosa. *Ovarium* globosum, glabrum, pauci-ovulatum. *Bacca* globosa, juventute flavescens glandulosaque, maturitate atra, corrugata.

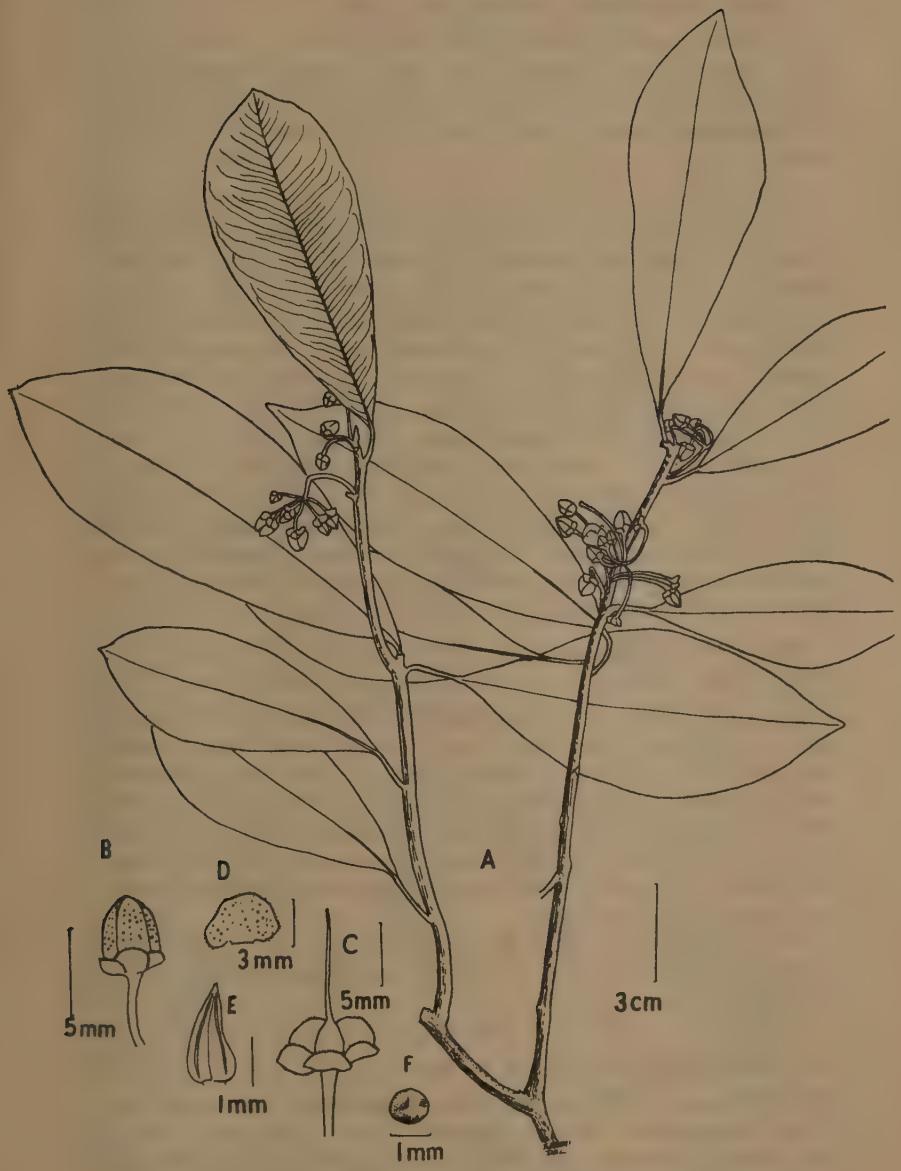
MALAYA: Pahang, Tahan River (Ridley 2,670—Holotypus in SING.): Jerantut (Holttum 24,746); Kota Glanggi (Henderson 22,438); Sungei Sat (Henderson 22,030); Raub (Strugnell 23,456). Omnia specimina in herb. Singaporense conservata.

The holotype specimen was referred doubtfully to *A. rhyncophylla* Clarke by King & Gamble in observation of *A. biflora* K. & G. in Materials IV (1905) 143, but it was not included as a Malayan species because of the imperfectness of the specimen.



Ardisia gambleana Furtado *(A, Ridley 2,670; B–F, Holttum 24,746)*

A, Ramulus fructiferus. B, Flos. C, Stamen antice visum. D, Ovarium. E, Placenta.



Ardisia tiomanensis Furtado *(Henderson 21,686—Holotypus)*

A, Habitus. B, Floris alabastrum. C, Flos petalis desumptis. D, Sepalum. E, Stamen postice visum. F, Placenta.

15. **Ardisia tiomanensis** Furtado **spec. nov.**

A. monticolae *affinissima, a qua foliis obovatis, inflorescentiis robustioribus, florum alabastris majoribus apice obtusis, sepalis semi-orbicularibus vel reniformibus valde imbricatis, extus deciduo violascenteque pubescentibus, margine ciliatissimis sat distinctissima.*

Arbusculus circa 8 m. altus, saxatilis, cum innovationibus violaceo-pubescentibus. *Folia* petiolis lepidotis supra canaliculatis circa 2 cm. longis stipitata, coriacea, obovato-elliptica, apice acuta vel acuminata, basin versus sensim acuta, utrinque deciduo lepidota, nervis multis reticulationibusque densis supra fere inconspicuis subtus prominulis percursa, multi-punctulosa vel punctulis absconditis inconspicuis diffusa, bicoloria. *Inflorescentia* axillaris, omnino deciduo violaceo-tomentulosa, ad 2 cm. usque pedunculosa, 5–10 flores umbellatim gerens; alabastra circa 6–8 mm. longa, 5–6 mm. in diam., apice rotundata, pedicellis 8–12 mm. longis, violaceo-pubescentibus suffulta. *Sepala* fere reniformia, medio multo dilata, valde imbricata, basi breviter connata, extus violaceo-pubescentia, minute punctulosa, margine pallida optimeque ciliata. *Petala* deciduo ciliolata vel scariosa. *Ovarium* glabrum; stylus ante anthesin haud exsertus. *Bacca* ignota.

MALAYA: Pahang, Pulau Tioman, prope Ayer Surin, alt. 300–700 m. (Henderson 21,686—Holotypus in SING.).

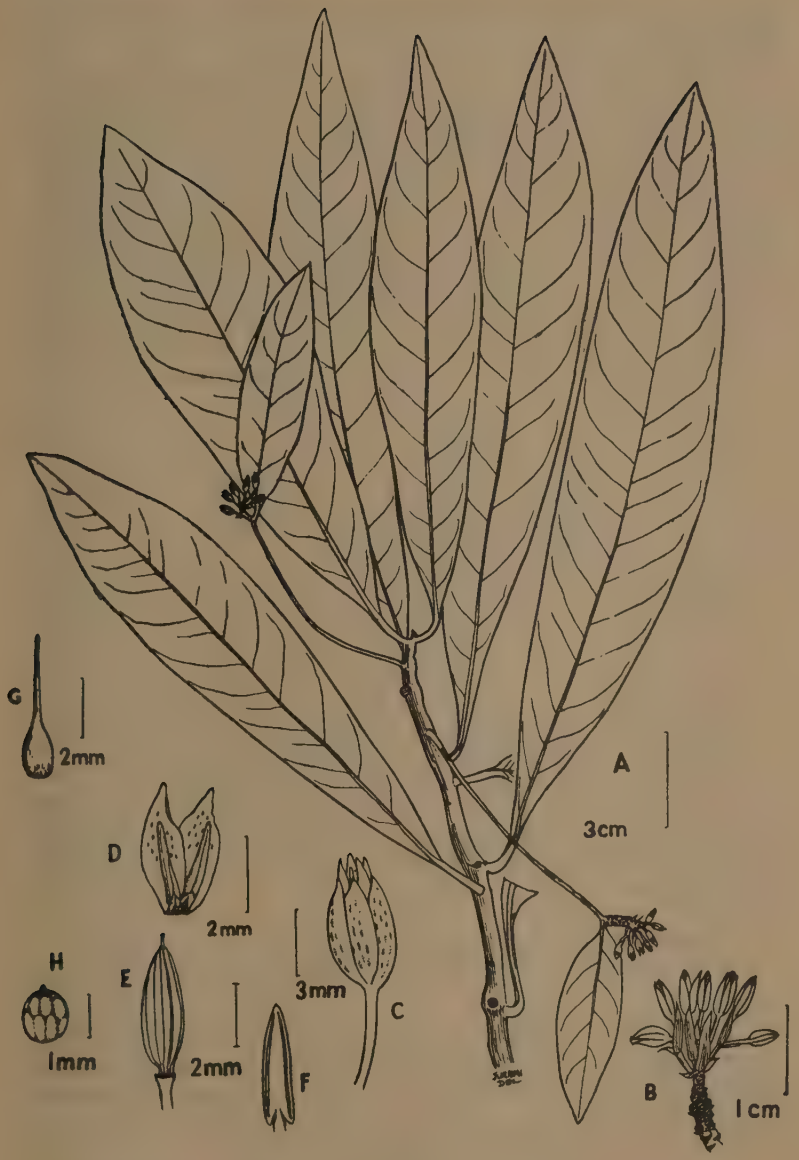
The collection has been distributed as *A. littoralis* Andr. which has very slender, acute flower buds, more united and glabrous sepals, narrower petals and septate anthers. Though the leaves are obovate-elliptic in *A. littoralis,* the violaceous pubescence is absent from the young growth. Similarly *A. tiomanensis* also differs from *A. monticola* which has elliptic-lanceolate leaves, no violaceous tomentum in any parts, very slender, acute flower buds, less imbricate sepals and acute petals.

The collector notes that this species is common in the rocky jungle, growing to 25 ft. or so tall and that flowers are pink.

Section Pyrgus (Lour.) Mez

16. **Ardisia calcicola** Furtado **sp. nov.**

Inter species ad Sectionem Pyrgum *pertinentes peculiarissima facile distinguitur: foliis intergerrimis dense punctulatis, nervis lateralibus interrupte absconditis, haud reticulatis; floribus in pedunculo abbreviato, longe bracteolato, apice ramuli producto valde congestis; pedicellis conspicue punctulatis; sepalis pro rata longissimis, fere ad basin usque liberis, quam petala punctulata*



Ardisia calcicola Furtado *(Endert 5,134, holotypus)*

A, Habitus. B, Inflorescentia. C, Flos. D, Petala duo cum staminis postice visa. E, Flos juvenilis sepalis desumptis ut stamina tubiformiter collata appareant. F, Stamen postice visum. G, Ovarium. H, Placenta.

circa ½-brevioribus, ovato-lanceolatis, utrinque lepidotis, atro punctulatis.

Suffrutex circa 50–75 cm. altus, flores in ramulorum apicibus lateralium racemoso-congestos gerens. *Folia* phyllotaxi in ramulis incerto excepto, subverticillatim collata, obovato elliptica, 30–35 cm. longa, 4–5 cm. lata, basin versus sensim attenuata, apice obtusa vel subacuta, eis ramuli 3–4-plo longiora, supra viridescentia, subtus brunnescentia, opaca, margine revoluta, utrinque pustulis minutis dense praedita, nervis primariis interrupte absconditis prope marginem arcuato ascendentibus utrinsecus circa 12, nervis secundariis fere parallelis inter primarios 1–2 fere inconspicuis percursa, haud reticulata. *Flores* 5–6 mm. longi; pedicelli 5–6 mm. longi, pustulati, bracteolis ovato-lanceolatis saepe acuminatis nonnihil breviores vel eis subaequilongi. *Sepala* utrinque lepidota, dextrorsum tegentia, atro-punctulata, petalis circa ½-breviora, fere ad basin usque libera, ovato- vel oblongo-elliptica, apicem versus sensim acuta. *Petala* sepalis paulo longiora, acuta, dorso punctulata. *Stamina* breviter stipitata, petalis vix breviora. *Ovarium* glabrum ovulis biseriatim dispositis praeditum.

BORNEO: in regione Centrali in provincia malaice Kutai dicitur, in saxis cretaceis, circa 30 m. alt. (Endert 5,134—Holotypus in SING.).

The collector notes that the shrub is 50–75 cm. tall, producing dark red flowers and growing on the edge of limestone rockface.

The calyx is rather long and deeply divided, but such long calyces are known to occur in the other sections of the genus. The flowers are in a bad state to admit a further scrutiny. No fruits are available. Because the flowers are borne at the apices of special branches and because the leaves are subverticillate, the species belongs obviously to the Section Pyrgus.

17. **Ardisia calophylla** Furtado **sp. nov.**

A. littoralis Andr. *sensu* Ridl., Fl. Mal. Pen. II (1923) 241 in obs.

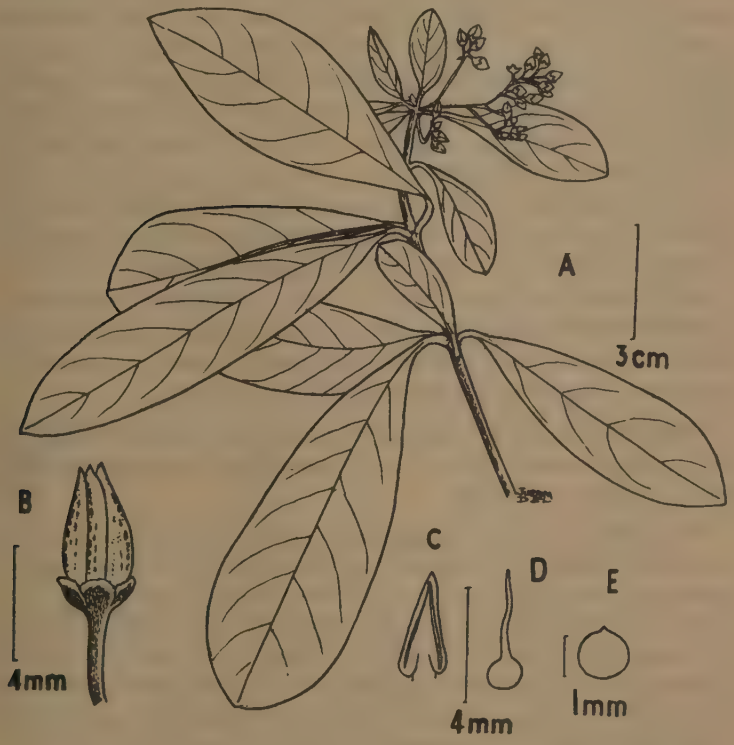
Ab A. kurzii, *cui affinissima, foliis minoribus, coriaceis, obovatis cum nervis reticulationibusque obscuris; inflorescentiis paniculatis, quam folia paulo brevioribus; sepalis suborbicularibus margine ciliolatis, sicut petala punctulatis; antheris acutis dorso glandulas paucas distantes gerentibus sat distincta.*

Ramuli glabri, in sicco sicut folia foenicolores. *Folia* glabra, punctis manifestis destituta, obovato-elliptica, apice arcuatim acuta vel breviter acuminata, 6–10 cm. longa, 3–4 cm. lata, basin versus

sensim cuneata, imo paulo decurrentia, petiolis supra sulcatis 5–10 mm. longis stipitata, nervis reticulationibusque fere obscuris praedita. *Inflorescentia* glabra, ramuli foliis subverticillatim praediti apice sita, paniculata, in ramulos floriferos valde divisa, ad 6 cm. usque longa. *Flores* ante anthesin conoidei; apice rotundati 3–4 mm. longi; pedicellis 3–5 mm. longis. *Sepala* basi 1/3 coalita, valde dextrorsum imbricata, fere orbicularia, glabra, dorso glandulosa, margine lutescentia, scarioso-ciliolata. *Petala* calyce subtripulo longiora, glandulosa. *Stamina* petalis paulo breviora, acuta, dorso pauciglandulosa. *Ovarium* ovoideum, glabrum.

MALAYA: Dindings, Bruas (Burn-Murdoch in 1909—Herb. SING.).

The collector notes that the flowers are white.



Ardisia calophylla Furtado *(Burn-Murdoch-Holotypus)*

A, Habitus. B, Flos per anthesin. C, Stamen postice visum. D, Ovarium. E, Placenta.

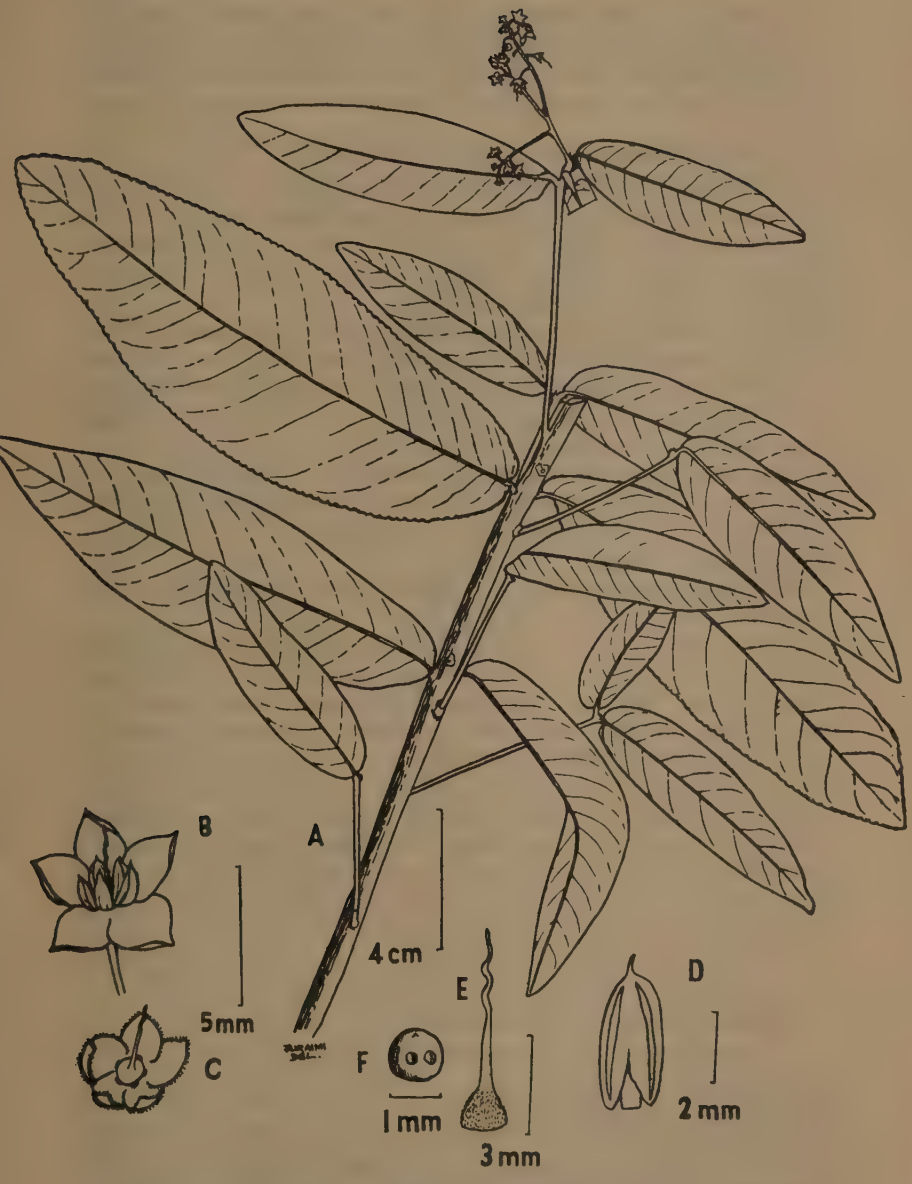
18. **Ardisia purseglovei** Furtado **sp. nov.**

A. candolleanae *valde affinis, a qua foliis ovoideo oblongis basi pseudo-cordulatis, subsessilibus, glabris, margine obscure crenulatis, glandulas magnas mox deciduas unocuique sinu singulas gerentibus, subtus minutissime punctulatis, cum nervis lateralibus reticulationibusque obscuris; sepalis tetrameris vel pentameris, extus tomentosis, intus glabris, margine ciliatis, eglandulosis; ovariis tomentellis facile distinguitur.*

Frutex circa 3 m. altus, cum ramulis spiculiferentibus 5–10 cm. longis. *Folia* coriacea vel chartacea, ovoideo oblonga, apicem versus arcuatim angustata, summo obtusa, basi rotundato truncata, imo ob rugas pseudo-cordulata, petiolis brevissimis ad 3 mm. usque longis stipitata, in ramulis spicas gerentibus subverticillata, margine obscure crenulata et revoluta, in unocuique sinu glandulas conspicuas deciduas singulas ferentia, nervis reticulationibusque obscurissimis praedita, subtus punctulis minutissimis dense aucta, 8–15 cm. longa, 2·5–4·5 cm. lata, utrinque glabra, novella subtus deciduo rubro-lepidota. *Inflorescentia* apicalis omnino tomentella, ex axi primario valde abbreviato, circa 2 cm. longo, in ramos circa 4, paulo ramulosos divisa. *Flores* in ramulis inflorescentiae primariis vel secundariis producti, tetrameri vel pentameri, pedicellis puberulis circa 5 mm. longis suffulti. *Sepala* coriacea, basi ¼–1/3-coalita, ovato triangularia apice obtusa vel subacuta, intus glabra, extus tomentosa, punctulis manifestioribus destituta, margine ciliolata. *Petala* calyce fere duplo longiora deciduo lepidotula, punctata. *Ovarium* pubescens, ovoideum, cum stylo tortuoso.

BORNEO: Sarawak, Gunong Pueh, alt. ± 150 m. (Purseglove 4670—holotypus in Herb. SING.). Specimina isoholotypica in K. et L. distributa non vidi.

The species is readily recognised by the ovate oblong, subsessile, pseudocordulate leaves having practically no reticulations and its lateral nerves inconspicuous, the inflorescence being hairy (the hairs are capitate), and the ovary puberulous. The leaf-margins are somewhat crenulate, but as the margins are revolute, the crenulations are not easily seen especially if the leaves are mounted with their lower surface glued onto the sheet. *A. brachythyrsa* has also subsessile leaves, but in that the leaves are much more rigid and coriaceous, almost obovate, having their nerves and reticulations quite conspicuous on both surfaces. The sepals are smaller there and less tomentose and the ovary is quite glabrous.



Ardisia purseglovei Furtado *(Purseglove 4,670—Holotypus)*

A, Habitus. B, Flos post anthesin. C, Flos petalis desumptis. D, Stamen postice visum. E, Ovarium. F, Placenta.

As the leaves are crenulate and bear a conspicuous gland in each sinus, the species may be easily put in the Section CRISPARDISIA as defined by Mez, but the mode of flowering and subverticillate leaves have led me to place species in the Section PYRGUS.

19. **Ardisia vaughanii** Ridl., Fl. Mal. Pen. II (1923) 248.

MALAYA: Perlis, Telor Jambu (Ridley 14,932, distributed as *A. sanguinolenta* Wall.?). **Kedah,** Gunong Baling (Kiah 35,383 & s.n. on 11–V–1938; Best 21,226; Nauen 38,022). **Perak,** Temengoh (Schebesta 2). **Pahang,** Kuala Tembeling (Holttum 20,552 & 24,723; Henderson 21,780).

The type was from Kelantan. Ridley placed this species in the Section TINOPSIS, but it should be placed in the Section PYRGUS (Lour.) Mez, the species being an ally of *A. kurzii* Clarke. Squires 848 from Anam, Indochina, distributed as *A. rigida* Kurz comes very close to the Malayan species.

According to the notes of the collectors, this is a shrub 6–8 ft. tall, bearing clusters of flowers having pale pink petals with dark centre, deep pink peduncles and pedicels, and red fruits which eventually turn black.

The following notes may be of use to supplement the original description:

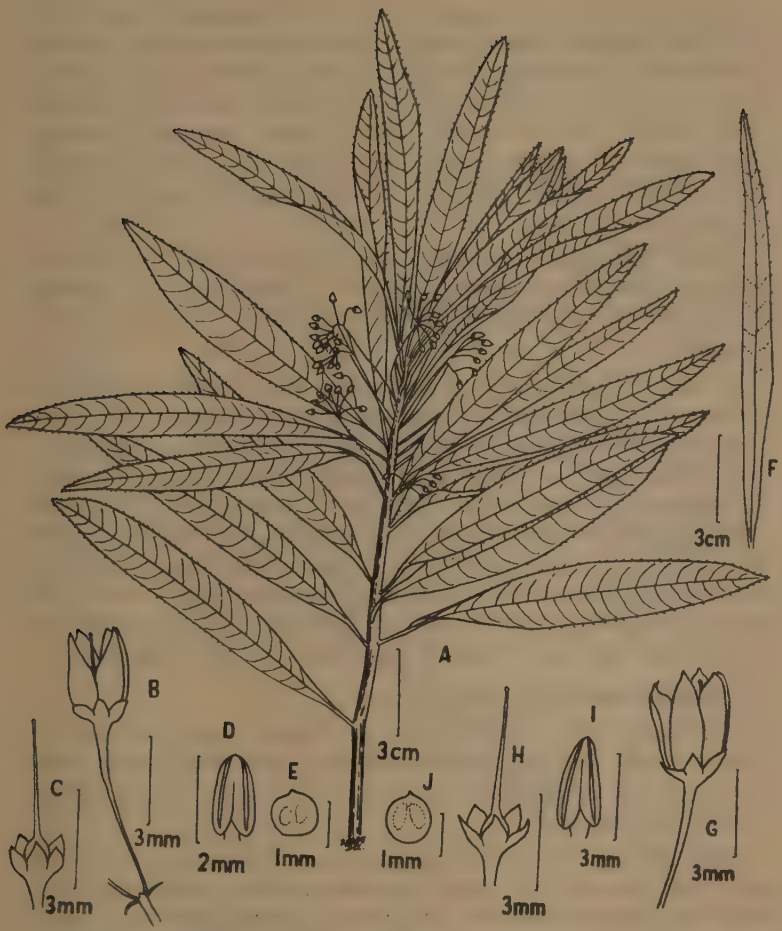
Leaves subverticillate on the main stem, with many small glands inconspicuous in some leaves, but generally quite conspicuous on both surfaces, glabrous. *Inflorescences* terminal usually borne on short lateral branches. *Peduncles* and pedicels deciduously puberulous and lepidote, somewhat ferrugineous. *Sepals* ovate triangular with rounded apex, 1/3 united at base, imbricate in buds, glandular and minutely puberulous on the dorsum, ciliate in margins. *Petals* with many glands, gradually acute. *Stamens* nearly as long as the petals, acute or mucronulate at apex, provided on the dorsum with no or few glands which are not black. *Ovary* glabrous. *Fruit* black when dry, longitudinally ridged.

Section BLADHIA (Thunb.) Mez

20. **Ardisia foliosa** Furtado **sp. nov.**

A. linearifolia Ridl. in Journ. Roy. Asiatic. Soc. Str. Br. 61 (1912) 27 et Fl. Mal. Pen. II (1923) 255, non *A. linearifolia* Miq. (1860); **Syn. nov.**

Suffrutex parte erecta 20–40 cm. longus, in parte basali repens vel subterranea ramulos erectos gerens, cum innovationibus minute puberulis. *Folia* subverticillatim congesta, membranacea, costis medianis exceptis minute puberulis utrinque glabra, lineari lanceolata 10–12 cm. longa, 15–20 mm. lata, utrinque sensim acuta,



Ardisia foliosa Furtado (*A–E, Holotypus; F–J, Merotypus A. linearifoliae* Ridl.)

A, Habitus. B, Flos post anthesin apice pedunculi situs. C & H, Flos petalis desumptis. D & I, Stamen postice visum. E & J, Placenta. F, Folium. G, Flos post anthesin.

apice plerumque mucronulata, margine valde denticulata et revoluta, supra brunnea, subtus pallidiora, nervis secundariis utrinsecus 16–20, reticulationibus remotis subtus prominulis supra obscuris praedita, glandulis novellis obscuris dein prominulis praecipue secus marginem et apice punctata, petiolis 10–15 mm. longis stipitata. *Inflorescentiae* axillares, simplices vel pauciramosae, axi

minute puberulae, cum pedunculis gracilibus bracteolatis, apice 3–8 flores congestis, infra apicem flores solitarios vel etiam ramulos florigerentes productis; pedicellis minute puberulis vel glabrescentibus 8–15 mm. longis. *Flores* 3–4 mm. longi, ante anthesin acuti. *Sepala* basi 1/3-unita, ovata, acuta, margine ciliolata, albescentia, dorso pauciglandulosa vel non. *Petala* ovato acuminata, interdum subito apiculata. *Stamina* petalis multo breviora. *Baccae* non visae.

MALAYA: Kelantan (Henderson 29,656—Holotypus). **Johore,** Sungei Kayu (Kiah 23,330). **Perak,** Gunong Bongsu (Haniff, Merotypus *A. linearifoliae*). Omnia specimina in Herb. Sing. conservata.

A. linearifolia Ridl. is an impriorable name since it is a later homonym. This and the fact that the species was based on a fragmentary material cultivated in the Botanic Gardens, Singapore, have induced me to establish a new species based on better material the duplicates of which have been widely distributed. In accordance with the definition given previously (Furtado in Gard. Bull. Straits Settl. IX, 1937 p. 289) I have employed the term merotype to designate the specimen taken from the type plant on which *A. linearifolia* Ridl. was based. In the plate figs. F–J are from the fragmentary merotype material preserved in herb. Singapore.

21. **Ardisia tumida** Furtado **sp. nov.**

Ab A. metallica, *cui affinissima ut videtur, caule haud pubescenti, ramulis novellis deciduo ferrugineo-furfuraceis, foliis margine eserratis undulatisque, petiolis subtus valde tumidis haec species sat distincta.*

Suffrutex circa 60–100 cm. longus, lignosus, in vivo cortice valde succosus, in sicco irregulariter angulatus, ramulis novellis axi deciduo ferrugineo-furfuraceis, 15–30 cm. longis praeditus. *Folia* saepe subverticillatim collata, petiolis 1–2 cm. longis, supra paulo alatis, sulcatis, subtus valde tumidis stipitata, obovato-elliptica margine undulata, membranacea, pellucida, utrinque glabra, basin versus paullatim angustata, imo sub-acuta, apice eleganter acuminata, 15–20 cm. longa, 4·5–7 cm. lata, nervis primariis utrinsecus 14–20 praedita, prominulo reticulata, glandulis minutis pluribus omnino dispersa. *Inflorescentia* stricte axillaris parva cum pedunculo 5–10 cm. longo, simplici vel bifurcato, 3–5 fructiferenti, pedicellis fructiferis gracilibus, circa 10 mm. longis. *Bacca* globosa, 6–7 mm. in diam., purpureo-glandulosa; sepalis 1/3-coalitis, carnosis, glabris, obscure glandulosis vel non.

Ardisia tumida Furtado *(Corner 30,290, holotypus)*

A, Fragmentum caulis cum fructu. B, Fragmentum caulis ut petiolus subtus tumidus appareat.

MALAYA: Kemaman in locis juxta flumina paludosis: Ulu Bendong (Corner 30,290—Holotypus in SING.): Sungei Nipah (Corner s.n. in Nov. 1935—SING.); Ulu Kajang (Corner s.n. in Nov. 1935—SING.).

The species is readily distinguished by its peculiar, water-holding cortex on the underside of the petioles, being very pronounced in older leaves. Similar cortex is found all over the stem, a reason why it dries to produce irregular ridges. Young twigs are covered with fugaceous, rusty-furfur· Leaf margins are undulate, but not serrate.

The collector notes that the plant is 3 ft. tall with pale red berries. No flowering specimen has been available.

HYMENANDRA A.D.C.

Hymenandra iteophylla (Ridl.) Furtado **comb. nov.**

Ardisia iteophylla Ridl. in Journ. Bot. LXII (1924) 298 et Fl. Malay Pen. V Suppl. (1924) 318: **basinymus.**

That the stamens are connate into a tube was noticed by Ridley himself; they have also a small free tip. In Ardisia the stamens are free.

This is a first record of the occurrence of the genus not only in Malaya, but also outside Assam.

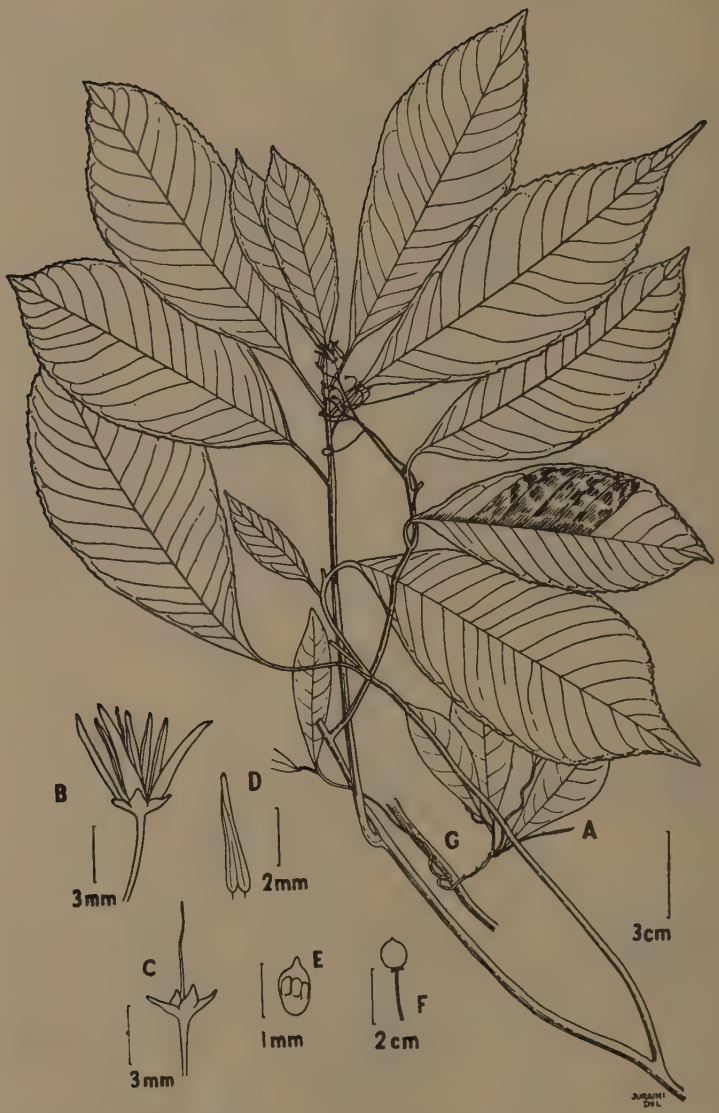
TETRARDISIA Mez

Tetrardisia corneri Furtado **sp. nov.**

A T. denticulata (Bl.) Mez, *cui affinissima, sed foliis majoribus, obovatis vel oblongis, inter venae nonnihil bullatis, inflorescentiis longioribus facile distinguitur.*

Suffrutex circa 60 cm. altus, lignosus. *Folia* obovato-elliptica vel oblonga, basin versus sensim attenuata vel subito angustata, imo acuta, apice acuminata, margine crenata, reticulationibus densis utrinque prominulis praedita, nervis primariis utrinsecus 12–20 percursa, inter nervos bullata, 15–20 cm. longa, 4·5–8 cm. lata, punctulis pluribus, atrescentibus praedita. *Inflorescentiae* terminales vel axillares, 5–6 cm. longae, pedunculis gracilibus, apice flores distantes gerentibus, vel etiam in 1–2 ramulos circa 1–2 cm. longos florigerentos divisae; pedicellis 8–10 mm. longis, minute puberulis. *Flores* tetrameri, ante anthesin acuti, 6–8 mm. longi. *Sepala* imbricata, basi 1/3-unita, ovata apice rotundato-acuta, dorso minute glandulosa, in fructu reflexa. *Petala* calyce fere quadruplo longiora, apicem versus sensim acuta. *Anthera* petalis vix breviora, apicem versus sensim attenuata, dorso atropunctata,

Hymenandra iteophylla (Ridl.) Furtado *(Holttum 10,973, Isotypus)*
A, Habitus. B, Inflorescentia. C, Floris alabastrum. D, Calyx. E, Flos ut tubus staminem appareat. F, Ovarium.



Tetrardisia corneri Furtado *(A–F, Corner, Holotypus; G, Corner, Paratypus)*

A, Habitus. B, Flos per anthesin. C, Flos petalis desumptis. D, Stamen postice visum. E, Placenta paulo tabida. F, Fructus cum pedicello. G, Inflorescentia in ramulum transformata (ex specimine paratypico mawaiensi).

longitudinaliter introrsum et per foramina apicalia dehiscentia. *Ovarium* ante anthesin unicum visum, imperfectum; stylus filiformis, paulo tortuosus, stigmate punctiformi praeditus. *Bacca* globosa, circa 6 mm. in diam., novella glandulis pluribus conspicuisque, in maturitate fere inconspicuis et sulcis verticalibus praedita.

MALAYA: Johore in locis paludosis: Sungei Berassau prope viam Mawai—Jemaluang (Corner sn.—Holotypus); Mawai (Corner sn.); Gunong Panti ad basin (Ridley—Dec. 8, 1892)—Omnia specimina in Herb. Sing. conservata.

The growth of inflorescence is somewhat similar to that in *T. tetrasepala* and the anthers appear to dehisce through both the apical pores and the longitudinal slits. Only one unopened flower was available (besides one opened one) and this had decayed somewhat. What looks like ovules in the ovary were really cavities.

One specimen (Mawai) had some inflorescences transformed into small plants, though its apical inflorescence bore fruits.

Probably Alvins 2336 from Malacca is this species, but the label does not belong here, for according to Alvins' notes the plant is a tree about 30 ft. tall with very hard, dark red wood. The leaves are longer, lanceolate elliptic or ovate elliptic, gradually narrowed to produce an acuminate apex and sub-rotund base. The specimen has scars of fallen peduncles.

Ridley's specimen from a herb grown in the Botanic Gardens, Singapore, in 1892 and figured in colours by Alwis in a plate preserved in the Singapore herbarium should also be assigned here, though being from a very young plant the leaves are smaller with shorter petioles. The drawing shows different shades of pink or mauve in the pedicels, calyx and corolla. Ridley suspected the plant to have come from Pahang.

Tetrardisia porosa (Clarke) Furtado **comb. nov.**

Ardisia porosa Clarke in Hook. f., Fl. Brit. Ind. III (1882) 522; Mez in Engl. Pflanzenr. IV 236 = Heft 9 (1902) 118; King & Gamble, Mat. Fl. Malay. Pen. IV (1905) 132; Ridl., Fl. Mal. Pen. II (1923) 248 fig. 97. **Basinymus.**

MALAYA: Perak, Taiping Hills (Henderson 10,454 & 10,438; Ridley 14,262); Gunong Hijau (Ridley in February 1891); Batu Togo (Wray 2,160); Larut (Scortechini 116[a]); Ayer Larut (Wray 39); Tupai (Wray 2,835). **Malacca,** Panchor (Goodenough) 1528). **Negri Sembilan** (Ridley in December 1890).

It is possible that the pollen shedding through apical pores of the anthers is also a characteristic of the genus Tetrardisia.

Tetrardisia tetrasepala (King et Gamble) Furtado **comb. nov.**

Ardisia tetrasepala K. & G. Mat. Fl. Malay. Pen. IV (1905) 352; Ridl. Fl. Mal. Pen. II (1923) 244—**basinymus.**

Ad descriptionem originalem adde:

Flores circa 10 mm. longi, ante anthesim valde acuti, tetrameri, 8–20 subumbellati, acropetales, in ramulo axillari vel apicali in singulos annos pedunculiformiter 3–20 mm. aucto siti; pedicelli graciles, 8–15 mm. longi. *Sepala* dextrorsum imbricata, ovata, apice rotundata, margine albescente nuda vel ciliolata, dorso minute punctulata, in fructu reflexa. *Petala* calyce fere triplo longiora, lanceolata, apice sensim acuta, punctulis parvis multis prope marginem picta. *Anthera* breviter stipitata, petalis vix breviora, apice sensim acutissima, dorso bene punctulata, introrsum longitudinaliter et per foramina apicalia dehiscentia. *Ovarium* glabrum vel minuti puberulum, cum ovulis paucis uniseriatim dispositis, stylo gracillimo, nonnihil spirali, petalis subaequante; stigmate punctiformi.

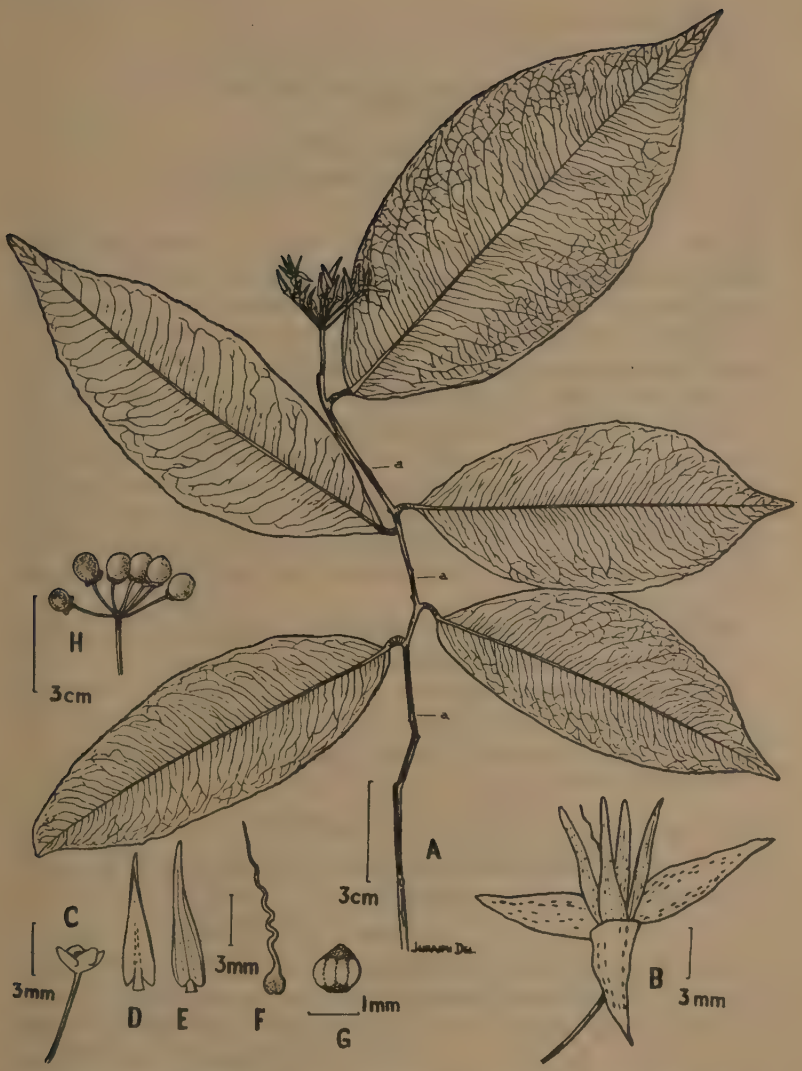
MALAYA: Johore, Gunong Pulai (Nur & Kiah 7,805—Apotypus; Ridley sn. & 12,193: Omnia specimina in Herb. SING.).

The inflorescence may be termed sometimes axillary and sometimes terminal. But what appears to be peduncles are really the current year growth of the axillary or terminal buds or twigs. When flowers and fruits are shed, the "peduncles" will grow again to produce flowers in the next season without producing any leaves. Later the same will produce one or more leaves before flowering again.

The tissues connected with the leaves produce a ridge on the stem from node to node and as the petiole of the terminal leaf grows much thicker than the main axis, the terminal inflorescence appears nearly axillary. This mode of growth also tends to make the stem zig-zag. Vestiges of fallen flowers may be seen on stem.

The anthers shed pollen both through apical pores and through longitudinal slits. The leaf margins are undulate and sometimes slightly crenate, and the petiole is often transversely wrinkled, the wrinkles acquiring dark brown colour.

Tetrardisia was not recorded to occur outside Java. King & Gamble had noted the tetramerous calyx, but they had no flowers to define the species generically. In the Singapore herbarium, of the three collections from the type locality in Johore (Gunong Pulai) only Nur and Kiah 7,805 have flowers which have served to place the species definitely into this genus. Hence it may be called the apotype. (cf. Furtado in Gard. Bull. Straits Settl. IX (1937) 288).



Tetrardisia tetrasepala (K. & G.) Furtado *(A–G, Nur & Kiah 7,805, Apotypus; H, Ridley 12,193)*

A, Habitus. A–a, Vestigia florum prioribus annis delapsorum. B, Flors per anthesin. C, Calyx cum pedicello. D, Stamen postice visum. F, Ovarium. G, Placenta. H, Umbella fructifera.

The Genus Sphagnum in Malaysia

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In the large genus, Sphagnum, the degree of affinity and variability of the species occurring in South-East Asia has not been fully worked out. Professor Le Roy Andrews has made very valuable investigations and has indicated the synonymy for South and North American species, and has made some reference to species from other tropical regions. Fortunately he was able to examine the types in the Warnstorf Moss Herbarium at Berlin-Dahlem. This herbarium which was entirely destroyed in the last war (Dalby, 1957), included the types described by Warnstorf in Sphagnologia Universalis (1911). In the absence of types for reference, the excellent critical work done by Le Roy Andrews before the destruction of the herbarium must form the basis of present day Sphagnum studies.

In this paper an account is given of the Malaysian Sphagna in the Herbaria at Bogor, Indonesia, and at Singapore.

The classification of the genus in this paper closely follows that of Andrews (1936). A complete synonymy is not given but new synonyms are indicated. Other synonyms can be found in Warnstorf (1911).

Key to the Species

1a. Cortical cells of stem and branches without spiral thickenings; some, at least retort-shaped
Subgen: LITOPHLOEA ..... 2.

2. Stem cortex cells all alike and all somewhat retort-shaped, branch leaves lacking a distinct border but with a resorption furrow ..... Sect. MALACOSPHAGNUM
1. *Sphagnum antarcticum.*

2. Stem cortex cells of two kinds, with retort cells only in the axils of leaves; branch leaves all bordered with one or more rows of narrow cells
Sect. ACISPHAGNUM ..... 3.

3. Small delicate plant, shining and iridescent when dry. Branch leaves not fibrillose ..... 7. *Sphagnum sericeum.*

3. Not iridescent. Fibres present in branch leaves. ..... 4.
4. Stem leaves lingulate to triangular lingulate with rounded fimbriate, laciniate or eroded apex ..... 5.
5. Stem leaves not fibrillose hyaline cells never septate ..... 3. *Sphagnum cuspidatulum.*
5. Stem leaves usually fibrillose in the centre, hyaline cells septate
4. *Sphagnum novo-guineense.*
4. Stem leaves triangular to triangular-ovate with a truncate tip ..... 6.
6. Chlorophyll cells lying centrally, exposed on both sides or exposed only on the dorsal side. Branch leaves not squarrose ..... 7.
7. Border of stem leaves broadened below
2. *Sphagnum cuspidatum.*
7. Border not broadened below ..... 8.
8. Delicate aquatic plant, branch leaves at least 3·0 mm. long
6. *Sphagnum flaccidifolium.*
8. Fairly robust species, branch leaves less than 1·5 mm. long.
6. *Sphagnum subrecurvum.*
6. Chlorophyll cells lying exposed only on the ventral side. Dry tip of branch leaves squarrose ..... 8. *Sphagnum junghuhnianum.*

1b. Cortical cells of stem and branches with spiral thickenings, not retort-shaped ..... Subgen: INOPHLOEA ..... 9.
2. Stem leaves very small, ovate or ovoid, about 500μ long ..... 9. *Sphagnum roseotinctum.*
2. Stem leaves at least 1·2 mm. long, lingulate to triangular ..... 3.
3. Hyaline walls adjacent to chlorophyll cells in branch leaves densely papillose
12. *Sphagnum borneense.*
3. Hyaline cells not papillose ..... 4.
4. Branch leaves with dorsal pseudopores
11. *Sphagnum beccarii.*
4. No dorsal pseudopores ..... 10. *Sphagnum holttumii.*

A. Subgenus **Litophloea** (Russ.) Andrews (1911)

I. Section MALACOSPHAGNUM C. Müll.

1. Sphagnum antarcticum Mitt. in Jour. Linn. Soc. IV (1859) 106; Bartr., (1942) 246.

Robust plant. *Main stem* cortex 2–4 cells thick, outer cells all more or less retort-shaped; wood cylinder distinct, solid, yellow to brown. *Stem leaves* triangular-lingulate to lingulate, 1·0–2·0 mm. long × 0·7–1·1 mm. broad, apex rounded, eroso-fimbriate. *Branch leaves* broadly ovate, about 2·5 × 1·4 mm., strongly imbricate, chlorophyll cells central, barrel-shaped in section, included between hyaline cells or free, hyaline cell-walls adjacent to chlorophyll cells smooth or papillose.

NEW GUINEA: Mount Wilhelmina, wet N. slope, burnt sub-alpine forest 3,400 m. (Brass & Myer-Drees 9737/BO.).

DISTRIBUTION: Australia, New Zealand, Stewart Island, Campbell Island.

This species, while typically a member of the small Malacosphagnum (Rigida) group differs from *S. compactum D.C.* in the relatively large stem leaves with their broad rounded, constantly fimbriate apex. The branch leaves have numerous dorsal pores at the commissures while the pseudopores, typical of *S. compactum,* are absent. The section of the branch leaves is similar to that of *S. compactum* with the chlorophyll cells included on both sides, in which feature it differs from *S. strictum Sull.* where the chlorophyll cells are exposed on the outer surface of the leaf.

II. Section ACISPHAGNUM C. Müll. emend Andrews (1911).

Series **Cuspidata** Schlieph

Chlorophyll cells of branch leaves exposed dorsally or central in position.

2. Sphagnum cuspidatum Ehrh. in Hoffm., Deutsch. Fl. 2 (1796) 22 Bartr., (1942) 246.

Delicate to fairly robust, often aquatic, pale green to pale brown. *Cortex* 2–3 cells thick; wood cylinder distinct. *Stem leaves* triangular-ovate; apex slightly truncate, dentate not lacerate; with a strong border considerably broadened below; hyaline cells fibrillose. *Branch leaves* long lanceolate, involute; apex toothed; margin entire with a border about three cells thick; hyaline cells fibrillose with strongly ringed pores at ends and corners of cells (dorsal); chlorophyll cells of branch leaves trapezoid in section with broader exposure on outer side.

SUMATRA: Si Garang Garang, wet place in forest, 1,400 m. (Polak 154/BO.); Polok Magae (Polak 156/BO.); Si Gelapang, 1,400 m. (Polak 157/BO.); Benkoelen Sikintjan Belirang, 1,400 m. (Rappard

98/BO.); Gunong Koerintiju 1,800 m. (Brunnemeyer 9602/BO and 1079/BO.); Petanei Valley, 1,300 m. (Lorzing 8487/BO.); Tongging, Toba Lake (Lorzing 8072/BO.); Tapianoeli, 1,400 m. (Polak 154/BO.); Gunong Goh Lemboeh, Top Plateau, 3,000 m. (van Steenis 10171/BO).

JAVA: Gunong Dieng (Rant Bogor-1656/BO.); loc. incert. (Moh Enoh 374/BO.).

BORNEO: Western Division Anjongan, North of Pontianak, sandy ground (Polak 157/BO.).

NEW GUINEA: Mount Wilhelmina, very wet place in bog, 3,450 m. (Brass & Myer-Drees 9758/BO.); Lake Habbema, common in bogs and lining edges of pools, 3,225 m. (Brass 9448/BO.).

DISTRIBUTION: North America, Europe, Asia.

The following numbers labelled in the Bogor herbarium as *S. subrecurvum* are definitely not this species. The stem leaves have a border strongly broadened below. I find no reason for not including them in *S. cuspidatum:*—

Brunnemeyer 9602; Rant (Bogor No. 1656); Toxopeus no number; Lorzing 8487; Lorzing 8072; Brunnemeyer 10479; Polak 154.

3. Sphagnum cuspidatulum C. Müll. in Linnaea 38 (1874) 156.

Fairly robust. *Main stem* cortex 2–3 cells thick; wood cylinder not distinct. *Stem leaves* triangular-lingulate to lingulate, not fibrillose; apex rounded laciniate; border narrow, not broadened below. *Branch leaves* in five rows, ovate lanceolate with a very narrow border; apex truncate dentate; hyaline cells with numerous pores on the dorsal side; chlorophyll cells triangular in section, lying dorsally.

CELEBES: Enrekang, Sawito, 1,800 m. (De Jong 108/BO.); Menado-Possomeer, 2,000 m. (Boschproefstation 13/BO.).

DISTRIBUTION: India, Siam, Malaysia.

3 (a) var. **malaccense** (Warnst.) Warnst. (1911) 187; Dixon (1926), 2 (misprinted as *S. cuspidatum* var.).

Sphagnum malaccense Warnst. in Hedwigia 31 (1892) 175.

Stricking pale brown colour when fresh. *Stem leaves* triangular-lingulate to spathulate 1·3–1·6 × 1·0 mm., not fibrillose; apex rounded, fimbriate; border indistinct. *Branch leaves* lanceolate about 1·3 × 0·5 with a border two to five cells thick. Apex narrowly truncate and split into four teeth.

CELEBES: Mamboeling by Mamasa (De Froideville 159/BO).

MALAYA: *Kedah,* Kedah Peak, common. ± 914 m., apparently commonest species (Holttum 14881/SING.) *Perak:* Gunong Batu Puteh, ± 2,100 m. (Wray 902, type, SING.). *Pahang:* Cameron Highlands (Henderson 17877b/SING.); ± 1368 m. (Holttum 23301/SING.); Gunong Batu Brinchang, abundant in forest near summit (Holttum 23530/SING. & BO.).

This variety is distinguished by its broad tongue-shaped or spathulate stem leaves, which may be fimbriate, not only on the

rounded apex, but also on the side margin. However this last is not a very constant feature.

3 (b) var. **trengganuense** Johnson **var. nov.**

Ab omnibus hujus speciei varietatibus hactenus cognitis caulibus flavo-bruneis, foliis caulinis partim fibrosis hoc taxon facile distinguitur.

Planta robusta, cum caule flavo-bruneo. *Folia caulina* triangulo-lingulata, partim fibrosa. *Folia ramea* plerumque 2 mm. longa, 0·6 mm. lata.

This variety differs from all the others hitherto described in the golden-brown stem and partly fibrous stem leaves. The plant is rather robust producing triangular-lingulate stem leaves. Its branch leaves are 2 mm. long, 0·6 mm. broad.

MALAYA: *Trengganu:* Gunong Padang, 4,000 ft. (Moysey & Kiah 31023, Holotypus in SING).

4. Sphagnum novo-guineense Fleischer & Warnst. in Warnst. (1911) 520.

Robust plant. *Main stem* cortex 2–3 cells thick distinct from the wood cylinder. *Stem leaves* triangular lingulate, about 1·3 × 1·0 mm.; apex rounded, a little eroded or eaten away; narrow border scarcely broadened below. Hyaline cells often septate and fibrillose in the centre of the leaf. *Branch leaves* broadly ovate-lanceolate; apex narrowly truncate, dentate, about 1·6 × 0·8 mm., with narrow border, pseudopores present on dorsal side; chlorophyll cells triangular in section exposed dorsally.

NEW GUINEA: Mt. Nellivig (Pulle 832/BO.); Mt. Goliath (De Koch 16/BO.).

5. Sphagnum flaccidifolium Dixon Ms. ex Johnson **sp. nov.**

A Sphagnum cuspidato, *cui proxima, ramis flaccidis, foliis caulinis triangulis utrinque recto-marginatis (haud arcuatim marginatis), foliis rameis multo longioribus, semper anguste limbatis, cellulas chlorophyllosas in sectione eorum transversali liberas utrinque ferentibus haec species sat diversa.*

Planta aquatilis. *Caulis* circa 1 mm. in diam., axi lignosus, epiderme 2–3 seriatim strata, manifeste diversa vestitus. *Folia* caulina magna, triangularia, recto-marginata, multifibrosa, circa 1·6 mm. longa, 1 mm. lata, apice cucullata et saepe bidentata, semper anguste uniformiterque limbata. *Folia ramea* perlonga, anguste lanceolata, 3–5 mm. longa, circa 0·5 mm. lata, anguste limbata, integerrima, apice truncata et 2–4 dentata, dorso poris interdum annulatis in cellularum medio instructa, in sectione transversali cellulis chlorophyllosis rectangulis vel trapezoideis liberis utrinque disposita.

An aquatic plant. *Stem* 1 mm. diameter, woody in the axis, covered with 2–3 layered, well differentiated epidermis. *Stem leaves* large, triangular with straight sides, multifibrous about 1·6 mm. long, 1 mm. wide, cucullate and often bidentate at the apex, and always with a uniform narrow border. *Branch leaves* very long, narrowly lanceolate 3–5 mm. long, about 0·6 mm. wide, entire, having each a narrow border and a truncate 2–4 dentate apex, and provided dorsally in the middle of the cells with pores which are sometimes thickened with rings; rectangular to trapezoid chlorophyll cells being seen exposed equally on both sides in the transverse section of the branch leaves.

MALAYA: *Selangor:* Telok Forest Reserve, 7th Mile stone, Klang (Carrick 500, Holotypus in SING.); Telok Panglima Garang (Holttum 28317/SING. & BO.).

SUMATRA: Near Pakan Borae (Holttum 28127/SING.).

The specific epithet was proposed on herbarium sheets by H. N. Dixon but, as far as I am aware, it has not been validly published before.

This species is remarkable in its flaccid branches and exceedingly long branch leaves. It is the only Malayan species found in the lowlands.

6. Sphagnum subrecurvum Warnst. in Allgem. Bot. Zeitschr. (1895) 134.

Fairly robust. *Main stem* cortex 2–3 cells thick with fairly distinct wood cylinder. *Stem leaves* ovate-triangular, 1·0 × 0·5 mm. to triangular 1·6 × 0·8 mm., all fibrillose, border present of equal width above and below. *Branch leaves* lanceolate, about 1·3 × 0·5 mm., apex narrowly truncate, dentate; with equal narrow border; pores minute, usually single; chlorophyll cells of branch leaves triangular in section, exposed only on dorsal side.

SUMATRA: Tapianoeli, Lantong Nihoeda (Polak 155/BO.); Dolak Margaoe (Polak 156/BO.); Si Gelapang (Polak 157/BO.); Danam Biloeloek (Jacobson 110/BO.); Hoetagindjang, Toba Lake (Ruttner in April 1929/BO.).

JAVA: Telaga Warna, 2,000 m. (van Steenis 4495 & 4545/BO.); Telaga Loemoe, (Bogor 2747/BO.); Telaga Tjibong, ± 2,000 m. (van Steenis 4495/BO.); loc. incert. (Scröter, May 1927/BO.).

7. Sphagnum sericeum C. Müll. in Bot. Zeit. (1847) 481; Bartr., (1942) 246.

Small delicate plant, shining, iridescent when dry. *Main stem* cortex 2–3 cells thick; wood cylinder distinct, yellow to brown in colour. *Stem leaves* triangular; apex acute; narrow, finely toothed border; 1·1 × 0·7 mm.; no fibres. *Branch leaves* ovate to

oblong-lanceolate; 1·1 × 0·4 mm., acute apex, serrulate border, no fibres, chlorophyll cells trapezoid in section, both sides exposed, longest side ventral.

JAVA: Tjibeureum (Fleischer s.n./BO.); alt. 1,700 m. near Waterfalls (Meyer B–3,447/BO. & B–1,099/BO.; van Steenis 2,136/BO.); Tjikundul valley, alt. 1,700 m. on rocks (Meijer B–3,826/BO.); Gunong Lalak 2,000–2,200 m. (van Steenis s.n. in VI–1941/BO.).

NEW GUINEA: Bernard Camp by Idenburg river, alt. 2,100 m. (Brass 12175/BO.).

BORNEO: West Koetai, Kemoel, alt, 1,700 m. (Endert 4530/BO.).

MALAYA: *Pahang:* Gunong Tahan, alt. 1,500 m. by stream (Holttum 20911/SING.); Cameron Highlands (Holttum 23530/SING.).

DISTRIBUTION: Malaysia.

A very distinct species easily recognized by its delicate nature, the shining iridescence of the leaves when dry, and the complete absence of fibres. Andrew regards the loss of fibres as secondary; their partial loss being exhibited in aquatic forms of the *cuspidatum* and *subsecundum* type. There is no justification for the creation of a separate section (Sericea Warnst., 1911) for the two diverse species—*S. sericeum* and *S. macrophyllum,* merely because they resemble one another in their complete absence of fibres.

Series **Acutifolia**

Chlorophyll cells of branch leaves exposed ventrally.

8. Sphagnum junghuhnianum Dz. et Molkenb., in Verhandel. d. Kon. Akad Wetensch. Amsterdam (1854); Bryol, jav. 1 27. Bartr. (1946) 246.

S. gedeanum Dz. et Molkenb. in op. cit. (1854); Bryol. jav. 1. 28.

Most robust, usually not shining when dry, often tinged with pink, pale red or violet. *Main stem* cortex 2–3 cells thick, distinct from the woody cylinder. *Stem leaves* triangular about 1·8 × 0·7–1·3 mm., auricles present or absent, not fibrillose or few to numerous fibrils in hyaline cells, border indistinct or distinct, not broadened below; tip truncate, toothed, somewhat squarrose. *Branch leaves* lanceolate to ovate lanceolate, never in five rows, dry tips squarrose; 1·5–2·0 × 0·4–0·8 mm., fibres few or many; border very distinct; dorsal pores numerous near commissures; chlorophyll cells triangular in section, exposed ventrally.

SUMATRA: Penghoeloe Bao, 2,000 m. (Frey-Wyssling 41/BO.); Ganjelanden, Gunong Goh Lemboeh, 2,700 m., in mossy forest (van Steenis 10223/BO.).

JAVA: Tjibeureum, 1,700 m. wet rocky walls and waterfall (Meijer 3448/BO.); 1,700 m., on andesite rocks (van Steenis 1156/BO.); 1,800 m. (Fleischer 501/BO.); Tjibodas (Massart 1262/BO.); Tjipanas

(Fleischer in Aug. 1900/BO.); Gunong Patoeha, near Kawah Poetih, under trees, wet semi-shady places. (Verdoorn, Series 1 in 1930/BO.); 2,200–2,300 m. (van Steenis 4429, 6920 & 6921/BO.); Gunong Papandajan, Tegal, grassland 2,350 m., wet valley of small river (van Steenis 4291/BO.); rock valley of small river, 2,350 m. (van Steenis 4806/BO.); Priangan, Tjiparoegpoeg 2,350 m., valley of small river (van Steenis 4806a/BO.); Gunong Oengaran, 2,050 m. (van Leeuwen 1248/BO.); Gunong Ardjoemo, 2,600 m. (Bremekamp/BO.); Air Panas on slope by hot springs (Meijer B-3999/BO.).

CELEBES: Gunong Ngilataki, East of Lindoe Lake, 2,355 m. (Bloembergen 3947/BO.); Gunong Bothian (Brunnemeyer 11968/BO.); Porema, 1,500 m. (Kjellberg 79/BO.).

NEW GUINEA: Mount Wilhelmina, wet slope, burnt subalpine forest, 3,400 m. (Brass & Myer-Drees 9738/BO.); Lake Habbema, 2,600 m., still water in stream (Brass 10897/BO.).

MALAYA: *Kedah:* Kedah Peak, ± 914 m., (Holttum 14882a/SING.). *Kelantan:* Gunong Sitong, ± 790 m., (Nur 12243/SING.). *Selangor:* Ulu Semangkok, (Ridley 277/SING.). *Malacca:* Gunong Ledang (= Mt. Ophir) (Ridley 221/SING.). *Pahang:* Gunong Batu Brinchang, ± 1,758 m. in open near summit, (Holttum 23529/SING. & BO.); ± 948–1,370 m., (Holttum 20918/SING.); Pine Tree Hill, ± 1,463 m. (Holttum 21561/SING.); Gunong Tahan; 1,066 m. on ground on the ridge, (Holttum 20914 & 20915/SING.); 1,525 m. on ground in wood, (Holttum 20905/SING.); 1,827 m. (Wray & Robinson 5435/SING.; (Ridley in 1908/SING.); Cameron Highlands, 1,553 m. (Henderson 17877a/SING.).

DISTRIBUTION: Japan, Formosa, Malaysia, Himalaya.

After careful examination of all the specimens available to me, I am convinced that *S. gedeanum* Dz. et Mb. is not a distinct species.

Warnstorf regarded *S. gedeanum* as a variety of *S. junghuhnianum*. I venture to suggest that there is no grounds even for varietal distinction. The "gedeanum" features, i.e. presence of auricle, indistinctness of border and absence or paucity of spiral thickenings in the stem leaves do not necessarily occur together in the specimens and seem to vary independently. The presence of auricles is very sporadic and found in specimens consigned to both "species". In only five specimens did I find no trace of spiral thickenings of the hyaline cells in the stem leaves. From this extreme there is a complete range from a few cells with spiral thickenings near the apex to complete thickening of all hyaline cells except for the border (cf. Suzuki, 1956). The distinctness or otherwise of the border seemed more probably to be a function of the age of the specimen and possibly its habitat than a specific distinction. It seems that *S. junghuhnianum* is a widespread and variable species in Malaysia.

B. Subgenus **Inophloea** (Russ.) emend Andrews (1911)

9. Sphagnum roseotinctum Johnson **sp. nov.**

A Sphagnum beccarii, *cui affinis, plantis partim roseis, cortice caulino multifibroso, foliis caulinis minoribus ovatisque haec species sat distincta.*

Planta partim roseo-tincta. *Caulis* crassus, 500μ in diam., axi lignosus, fusco-rubidus, cortice 3 strato, multi-fibroso, cum cellulis superficialibus externe uniporosis vestitus. *Folia caulina* ovata, parva, 500μ longa, 250μ lata, fibroso. *Folia ramea* ovata cucullata, 2 mm. longa, 0·7 mm. lata, cellulis chlorophyllosis anguste trapezoideis in sectione eorum transversali utrinque libere disposita.

Plant partly tinged rose. *Stem* thick, 500μ in diameter, woody and dark red in the axis, covered with 3 layered, multifibrous cortex, which has the superficial cells provided externally with one pore each. *Stem leaves* ovate, small, 500μ long, 250μ wide, fibrous. *Branch leaves* ovate, cucullate, 2 mm. long, 0·7 mm. wide, with chlorophyll cells narrow trapezoid in section and free on both surfaces, but with greater exposure on the ventral side.

MALAYA: *Kelantan:* Gunong Sitong, on ridge 792 m. (Nur 12244/SING., holotypus). *Kedah:* Kedah Peak (Spare 1439 & 1430/SING.).

This species is clearly distinct from *S. beccarii* in the numerous fibres in the stem cortex and in the very small stem leaves.

10. Sphagnum holttumii Johnson **sp. nov.**

Sphagnum magellanico *similis, sed foliis caulinis brevissime lingulatis, cellulis chlorophyllosis in sectione folii ramei transversali rectangulis utrinque vel in latere ventrali tantum liberis haec species sat diversa.*

Epidermis caulina 3-strata, multifibrosa, cum cellulis superficialibus externe uniporosis. *Folia caulina* parva, lingulata, fibrosa, 2 mm. longa, 0·6 mm. lata, elliptico-ovata, apice cucullata, concava, foraminibus magnia in cellularum angulis et prope commissuras instructa, cellulis chlorophyllosis in transverse sectione rectangulis, liberis ventre vel utrinque liberis praedita.

Stem epidermis three layered, multifibrous, with the superficial cells provided each with a single pore. *Stem leaves* small, lingulate, fibrous, 2 mm. long. 0·6 mm. wide, cucullate and concave at the apex, and provided with large pores at the cell angles and junctions chlorophyll cells in transverse section being exposed ventrally or on both sides.

MALAYA: *Pahang:* Gunong Tahan, alt. 1,500–2,000 m. in sandy and other places, and in the open or shady localities (Holttum 20906, holotypus in SING.; 20908; 20909; 20910; 20916 and 20919—all in SING.); Cameron Highlands, alt. 1,250 m. in swamp (Holttum 23300/SING.). *Kedah:* Kedah Peak (= Gunong Jerai), alt. 1,250 m. (Abdul Kadir 19771/SING.). *Johore:* Gunong Pantai, alt. 500 m. (Corner 23207/SING.).

This species differs from *S. magellanicum* in the shape and position of the chlorophyll cells and the shape of the stem leaves.

11. Sphagnum beccarii Hpe. in Nuovo Giorn. Bot. Ital. (1872) 278.

Sphagnum pauciporosum Warnst. in Hedwigia 39 (1900) 109; cf. Andrews (1951).

Robust species. *Stem* with cortex about three cells thick, fibres few. Outer cells with large single pore/cell. Wood cylinder distinct, chocolate brown, pith pale yellow, thick walled cells. *Branches* 1·2 cm. long, blunt, turgid. *Stem leaves* lingulate, 1·75 × 0·75 mm., spiral thickenings near to apex, fimbriate tip; numerous large dorsal pores median in hyaline cells, often almost equal to cell diameter, no border. *Branch leaves* wide imbricate, concave, about 1·72 × 1·5 mm., tip obtuse, cucullate, denticulate; ventral pores near cell walls; pseudopores present dorsally, chlorophyll cells trapezoid included dorsally.

SUMATRA: Gunong Kenieri, 3,200–3,300 m. (van Steenis 10256/BO.).

BORNEO: Bei Kenepei (Fleischer, Serie II-1899/BO.).

MALAYA: *Pahang:* Cameron Highlands, 1,548 m. (Henderson 17877c/SING.).

DISTRIBUTION: Malaysia.

In his paper Andrews (1951) "hesitates to suggest" that this species is synonymous with *S. erythrocalyx* or *S. leionotum* but points out several features of similarity with these South American species. There is little material available of *S. beccarii* for the detailed study needed to determine this point.

12. Sphagnum borneense Warnst. in Allgem. Bot. Zeitschr. (1895) 229.

Moderately robust. *Main stem* cortex fibrous, 3–4 cells thick, outer cells with 1–4 pores. *Stem leaves* triangular with dentate tip, about 1·3 × 0·5 mm., no fibres in hyaline cells. *Branch leaves* large, concave, rounded, cucullate, ovate to oval, 1·5 × 0·8 mm., chlorophyll cells very small triangular in section, included on dorsal side; hyaline walls adjacent to chlorophyll cells densely papillose.

BORNEO: *Sarawak:* Mount Santubong (Native collector 2236/BO.).

The specimen examined by Andrews came to Europe as packing material and Andrews doubts if it came from Borneo at all. The specimen at Bogor seems a perfectly genuine collection from Borneo. It is very like *S. papillosum,* but even more papillose.

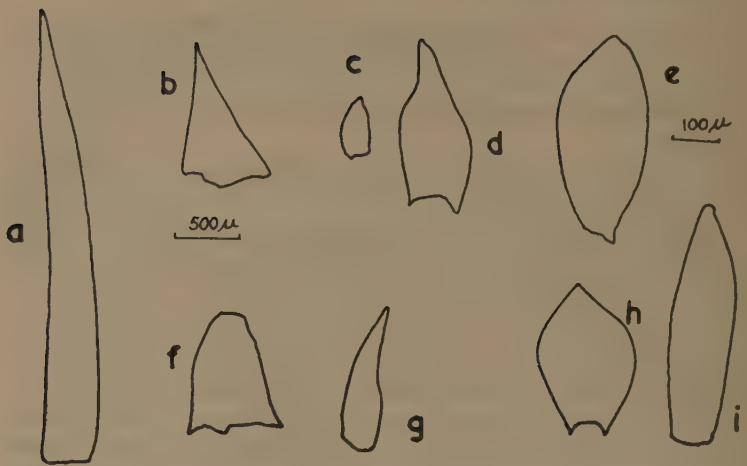

Fig. 1. *Folia. S. flaccidifolium:* a = folium rameum; b = folium caulinum. *S. roseotinctum:* c = folium caulinum; d = folium rameum; e = folium caulinum valde ampliatum. *S. cuspidatulum* v. trengganuense: f = folium caulinum; g = folium rameum. *S. holttumii;* h = folium rameum; i = folium caulinum.

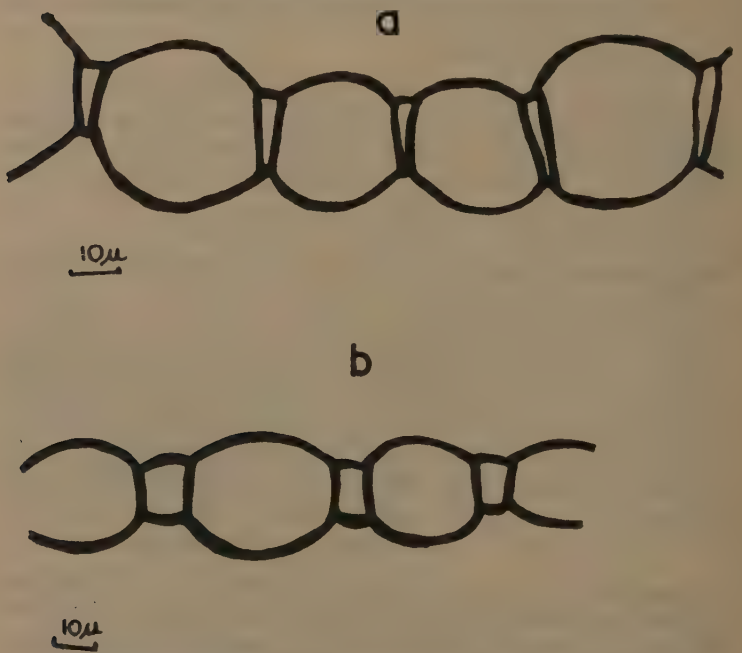

Fig. 2. Sections transversales. a, *S. roseotinctum;* t.s. folii ramei. b, *S. holttumii:* t.s. folii ramei.

Acknowledgements

This work was carried out in the Department of Botany, University of Malaya in Singapore, and I wish to acknowledge the help and encouragement of Professor H. B. Gilliland. The specimens were made available by the Directors of the Botanic Gardens in Singapore and in Bogor. I would like to thank the staff of the Kebun Raya, Indonesia, who made my trip to their herbarium a most enjoyable one. Lastly I would like to thank Dr. C. X. Furtado who gave considerable taxonomic help and translated the Latin diagnoses.

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Cleome ciliata Schum. et Thonn. in Singapore

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Among the many ecological problems awaiting solution in Singapore Island, is the rapid spread of introduced weeds on soil bared by land utilisation. In recent years *Cleome ciliata* Schum. et Thonn. has shown wide distribution, occuring as a weed of waste-ground, manure heaps and in exposed situations along the drains of roadsides. This plant of tropical African origin (Hutchinson and Dalziel, 1927) is widely distributed both in tropical Africa and Jamaica. It was first collected in Singapore in 1927 and since then has spread rapidly over Singapore Island and is locally abundant in parts of the Federation of Malaya. In this paper some suggestions will be made as the reasons for its rapid spread and its successful colonisation of exposed sunny land. Other features of ecological interest will also be mentioned.

The Good Colonising Power of Cleome ciliata in Singapore

Studies of the autecology of this species showed that particular features of its morphology and life history gave it considerable selective advantage in colonising bare exposed soil in Singapore.

(a) Vegetative development

The root system is a spreading one which consists of lateral roots extending horizontally and forming a circular mat at a depth of 5–10 cm. from the surface. For a well grown plant which sprawls over an area of 120–160 cm. diameter, the root system will form a mat some 60 cm. in diameter. Growing in this particular way, the roots meet with little competition from other species of plants growing in the same habitat. For instance *Phyllanthus niuri, Euphorbia hirta, Oldenlandia corymbosa* and *Alternanthera speciosa* have tap root systems in which the central main root grows straight down to a depth well below that of the *Cleome ciliata* root zone. Shallowly rooted sedges and grasses do not penetrate below the first 6 cm. of soil. (Fig. 1).

The plant grows erect to a height of 30 cm. and then falls flat on the ground where it continues to grow and flower. Such flat sprawling plants have a good chance of survival in an exposed situation.

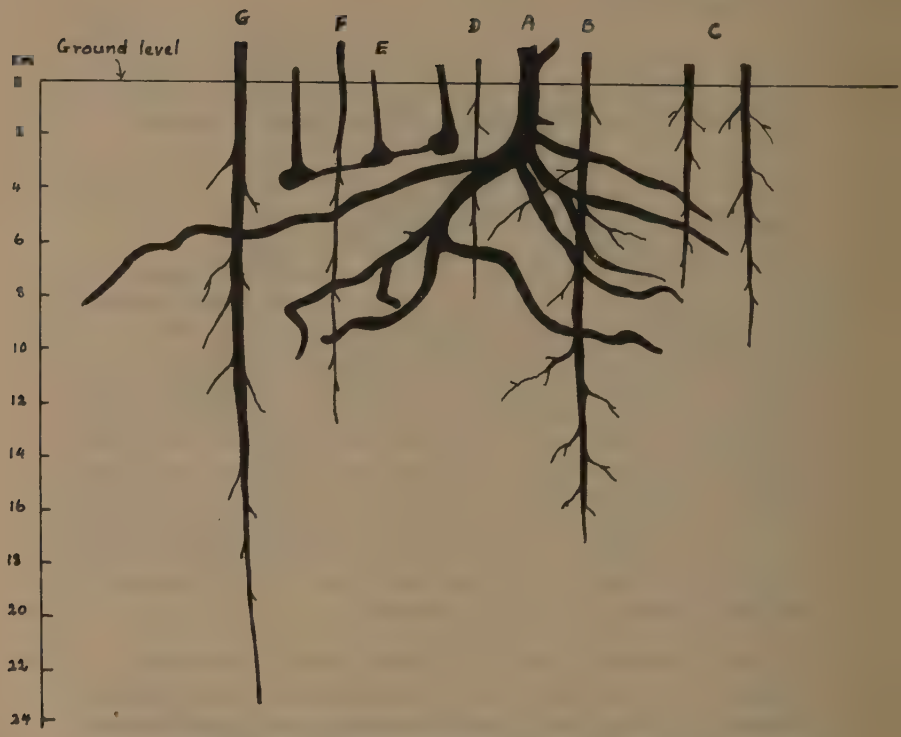

Fig. 1. Root systems of other herbaceous plants growing in association with that of *Cleome ciliata;* (A) Cleome ciliata; (B) Alternanthera triandra; (C) Phyllanthus niuri; (D) Oldenlandia corymbosa; (E) Cyperus spp.; (F) Borreria latifolia; (G) Euphorbia hirta.

(b) Reproduction

The flowers are distinctly dimorphous with respect to the ovaries of the mature flower. In the *normal ovary flower,* the mature ovary is almost as long as the filaments of the shortest pair of stamens (8·0–10·0 mm. long), about 1·0 mm. in diameter and bears a pink, papillose, sticky stigma. In the *short ovary flower*, the mature ovary is only 2–3 mm. long and 0·5 mm. in diameter. The stigma is green and undeveloped and no seed is set. (Fig. 2). Both types of ovary occur on the same plant and the ratio of normal ovary flower/short ovary flower varies from 1·1 to 2·0, i.e. there are always more normal ovary flowers than sterile short ovary flowers.

Artificial pollination experiments showed that while the pollen of both types of flowers was viable and successfully fertilised the normal ovary flowers; the short ovary flowers would not set seed either with pollen from flowers of its own type or with pollen from the normal ovary flowers.

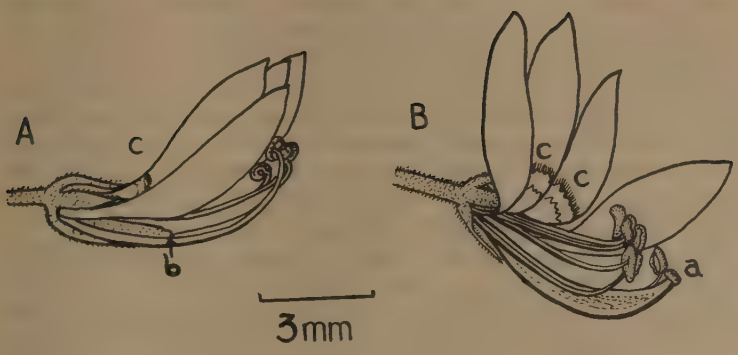

Fig. 2. Flowers of *Cleome ciliata*

A, Short ovary flower with abortive ovules and undeveloped stigma (b).

B. Normal ovary flower with fertile ovules and papillose stigma (a).

In A and B, "honey guides" are indicated (c).

In the field *Apis indica*, a honey bee, is a regular visitor to both types of flowers collecting nectar and pollen. Owing to the proximity of the lower pair of stamens and the stigma of the normal ovary flowers, self-pollination may also take place to a limited extent. The short ovary flowers seem simply to furnish additional supplies of pollen, so that fertilisation of the normal ovary flowers is assured. In the field it was observed that between 50 per cent and 71 per cent flowers set seed and only a few of normal ovary flowers failed to be fertilised.

The seeds are attached along the sutures formed by the two carpels of the fruit and average 50 seeds per pod. They are small and reniform with the embryo curled up with the sharp radicle end touching the cotyledons to form a disc-like structure. The seed coat is thick and transversely corrugated. On either side of the tip of the seed coat are two float-like structures called here "elaiosomes". The elaiosomes which are full of fatty substances, develop from the tips of the outer integuments from special cells differentiated before fertilisation. Three days after fertilisation these cells form a bunch-like structure which enlarge and appear as glistening structure as the mature seed turns from brown to black on ripening.

When the fruit is mature, it splits from below upwards forming two valves. Some seeds are shot out immediately while others are retained and later jerk out by movements of the plant in the wind,

or are carried away by ants. The succulent elaiosomes are particularly attractive to ants. They carry the seeds away and eat the elaiosomes leaving the seed scattered abroad.

The seeds are lighter than water. This is partly due to the corrugated seed coat which causes it to resist wetting; and partly to the fat content of the elaiosomes which act as flotation devices. Since one common habitat of *Cleome ciliata* is along drains and canals on Singapore Island it is quite probable that the seed find new habitats by dispersal for short distances in the water.

Experiments were done to test the viability and longevity of the seed of *Cleome ciliata*. It was found that fresh seed would not germinate in the dim light of a laboratory, but seeds, in similar germinators placed on a windowsill receiving at least two hours direct sunlight a day, germinated with a variable percentage germination according to the seed sample used. Air drying of the seed for 1–7 days does not apparently decrease the percentage germination of samples, but air drying for four months decreases it to 4 per cent.

This apparent marked effect of light is interesting since *Cleome ciliata* is essentially a plant of sunny wastelands and is never found deep in the forest, nor in shady situations. If seeds found their way to such a habitat they would fail to germinate. Removal of elaiosomes does not affect the percentage germination, therefore ant-dispersal is quite feasible.

(c) Establishment of seed

When seed of *Cleome ciliata* are sown thickly in a garden a good percentage germination is obtained, but not all the seedlings will survive. There is a marked effect of crowding resulting in the production of etiolated thin plants, producing flowers somewhat smaller than normal. In one experiment only 58 per cent plants had survived after 52 days.

Such overcrowding by plants of the same species is unlikely to occur in the field due to the diverse methods of seed dispersal which ensures a wide range of destination for seed produced by any one plant. Nevertheless *Cleome ciliata* meets competition from taller life-forms, colonising bare ground in the next stage of the succession. In the field it reacts rapidly showing etiolation of stems, yellowing of leaves, smaller flowers and fewer seeds. If a locality is completely covered with grasses such as *Ischaemum;* or with *Mimosa pudica* or *Cyperus* species *Cleome ciliata* never becomes established. Heavy shade from trees or scrub (e.g. *Adinandra dumosa*/*Wormia suffruticosa* scrub) stops the colonisation by this plant.

DISCUSSION

Cleome ciliata is particularly successful as a pioneer weed colonising bare ground. Its roots system is relatively shallow and does not tap the same zones as other pioneer weeds growing in the same vicinity. It has a very rapid growth and by its prostrate habit soon covers extensive areas of bare soil. It has prolific production of seeds which have a wide range of dormancy (from 10 to 126 days).

These are typical microbiotic seeds of a tropical climate (Crocker & Barton 1953). About 50 per cent flowers set seed. The other flowers are short ovary "pollen flowers" and have a sterile ovary. The seeds are dispersed by splitting of the pod, by being carried away in water currents of floodtide, or by ant-dispersal.

In very exposed situations the stem and adaxial leaf surface developed an erythrite red colour. The flower size was reduced and the number of seeds per fruit decreased. These effects which were not investigated further may well be due to a mineral deficiency.

The tender leaves and shoots are the favourite food of the larvae of a butterfly (*Appis libytheae olferna*). The Capparidaceae are often the food plants of the Pieridae to which family *Appis libytheae olferna* belongs (Corbet & Pendlebury, 1956). Although damage may be done to individual plants, the plants are far too numerous to be exterminated.

SUMMARY

1. *Cleome ciliata Schum. and Thonn., 1828,* a native of Tropical Africa was first collected in Singapore in 1927 and since then has spread throughout the Island and in the Federation of Malaya, growing in open waste-land and by roadsides.

2. The plant produces two types of ovaries:—"normal" ovary which is fertile; and "short" ovary which is abortive. Both types are produced on the same plant. All pollen produced is viable.

3. The seeds bear two, float-like structures, called here "elaiosomes" are not essential for germination of these seeds.

4. The elaiosomes play a double role in seed dispersal. They are partly responsible for the flotation of seeds; and they provide food for ants which scatter the seeds. The elaiosomes are not essential for germination of these seeds.

5. The percentage of germination of seed varies greatly but no germination was observed unless they were exposed to direct sunlight of at least 2 hours duration/day. This effect may be due either to true light sensitivity or to the effect of increased temperature.
6. The morphological development of the plant from germination to fruiting is traced.

ACKNOWLEDGEMENTS

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OBITUARIES

Haji Mohamed Nur bin Mohamed Ghous, B.E.M.

MOHAMED NUR BIN MOHAMED GHOUS was born in Singapore "during Bulan Puasa" in 1898. This was before registration of births was a general practice and his birth appears to have been undocumented. In that year Puasa occurred during March. Later his birth was dated 22nd March, 1898.

His father was a Malacca Malay who travelled between Malacca and Singapore trading in cloth. His mother, Yang Chik binte Saman, was a Singapore Malay. They had four children, three boys and one girl.

Mohamed Nur's schooling was brief. He went first to the Kota Raja Malay School in Singapore. After that he attended the Lorong Pandan English School, a branch of the Government Victoria School.

He joined the Gardens service in 1911 or 1912 at the age of 13 or 14 years during the close of H. N. Ridley's directorship and was employed on collecting seed for distribution in Malaya and overseas. Much of this work was with hevea seeds for which the Gardens were the main source of supply.

After Ridley's retirement, I. H. Burkill was appointed Director. He arrived on 17th October, 1912, ten months after Ridley's departure. They had been months of less than standstill. The printed literature which had come into the office was in a heap on a table, thrown there as it arrived. In the herbarium the mounted plants were in their cabinets, but the cabinets were in no systematic arrangement. The Penang Gardens had been closed in mid-1910 and the land transferred to the Georgetown Municipality to make a water reservoir. The Penang herbarium had been transferred to Singapore. The sheets remained in the cabinets used in Penang, but no start had been made to incorporating it with the Singapore herbarium. Nor were the cabinets in any order, but simply stacked wherever there was room.

To set about sorting out the confusion, Burkill picked out Ahmad bin Hassan as Storekeeper and Mohamed Nur as Label Printer as from 1st January, 1913. The duties of this latter post were more varied than at present understood and Mohamed Nur had the run of the herbarium for his ability to label plants in the garden fitted

him for the same function in the herbarium. Thus began his association with the herbarium which was to continue for the rest of his life.

For the herbarium to be at all usable it had to be got into order. The cabinets were of miscellaneous sizes and did not block nicely, but by sorting them out the best use of space was achieved. This led of course to worse confusion in the sequence of families. Since all the herbarium sheets were in labelled folders (according to the Bentham and Hooker system), it was left to Mohamed Nur to rearrange them. Commenting on the ability he displayed in doing this, Burkill has said: "Nur means Light, and this is where he shone it". As science, whatever its context, is the pursuit of truth, it seems wholely appropriate to quote R. J. Wilkinson [A Malay-English Dictionary, 1955]: "**Nur** Ar. Light—whether the solar light by which men see, or the primal light that illumined chaos at the Creation, or the light of divine revelation that guides men to Truth". As Mohamed Nur was to give his life-work to the herbarium, and developed an innate perspicacity for botanical taxonomy, how appropriated was he named!

Nur's growing knowledge and an unusual habitual orderliness clearly pointed his career to greater responsibilities. On 1st September, 1916 he was promoted to become Plant Collector. His collecting was extensive and he held the post till the end of 1923, when the post of Herbarium and Museum Assistant having fallen vacant, he was appointed to it. I. H. Burkill, in recommending to Government his promotion wrote: "The subordinate whose name I put before you is singularly efficient and energetic, and is capable of higher work than that of plant collector. He has acquired a surprising knowledge of the latin names of Malayan plants, and by his methodical ways is calculated to keep the Museum and Herbarium in due order".

The post of Herbarium and Museum Assistant to which he came on 1st January, 1924 was held by him throughout the rest of his career. He retired on pension on 22nd March, 1953 on attaining the age of 55 years after over 40 years service which he was yet to extend by another 5½ years. At the time of his retirement he had acquired such a comprehensive knowledge of Malaysian plants, and there being no-one available to fill his late post, that after a break of one day as is required by regulations he was re-engaged in the same post. This he held to the day of his death, 7th November, 1958. During this time he saw the herbarium grow to be the fourth largest in Asia with a collection of about 400,000 specimens to which he personally had in no small measure contributed.

In the field, he visited most parts of Malaya; he also collected in Thailand, Sumatra and Rhio. In his earlier days he accompanied I. H. Burkill extensively over Malaya, and with Mohamed Haniff, Superintendent of the Penang Gardens, went to many places in the northern half of the peninsula, the most extensive expedition being made in January and February 1923 in Ulu Kelantan to the northern side of Gunong Tahan. After Holttum and Henderson had joined the Department in 1922 and 1924 respectively Mohamed Nur accompanied them on many expeditions between then and the war, from Langkawi and Perlis in the north to the southern end of the peninsula, from the coastal plains and the mountains of the west to the east coast and the off-shore islands of the Pahang/Johore group. He also went in charge of independent assignments and in October and November 1937 collected in Selangor for the Arnold Arboretum, U.S.A., in conjunction with the F.M.S. Department of Forests.

All his collecting is numbered in the field in the S.F.N. (Singapore Field Number) series and his collections are laid in the Singapore Herbarium with duplicates sent out to many other herbaria. A list of his major collecting trips is given at the end of this notice. On one of them he took the only known Malayan flowering specimen of *Bambusa pauciflora* Ridl. which he got on the ridge leading to the summit of Pine Tree Hill (4,780 ft.) on the Pahang-Selangor border.

Ridley's *Flora of the Malay Peninsula* was published between 1922 and 1925, the major part being out by 1924. With this as the standard record of the Malayan flora, the sheets in the Singapore Herbarium were rearranged in accordance with its sequence. This work naturally fell to Mohamed Nur and occupied him for much of 1924/25.

Immediately following on this Mohamed Nur undertook in 1926 the integration of the Perak Museum herbarium with the Singapore herbarium. And for several years leading up to 1928 he carried out various assignments for the F.M.S. Forest Department herbarium for which the F.M.S. Government gave him an honorarium. These services were in fact regularly rendered by Mohamed Nur right up to the time of his death and by the Gardens Department generally then and now as a part of the Department's fundamental purpose of studying the Malayan flora.

Mohamed Nur's contribution to the knowledge of the local flora is not marked by any list of publications. His efforts have been merged with and are contained in the publications of others to whom he rendered ready and competent assistance in undertaking

preliminary determinations of collected material. These determinations were made with an unusually gifted knack, but entirely lacking the substantial pedestal of scientific theory and precept, which of course he had never received. His ability to "spot" sterile material raised as much admiration as anxious doubts amongst the conventional, but so often could it be shown subsequently that he was usually right. Every generation produces a few men of genius, and here in a humble way was one of them.

In the field of botany as in other sciences recognition of merit is often acknowledged by co-workers by the use of personal names to label some object or phenomenon. Bestowing of personal names for new species or genera of plants is common and Mohamed Nur's name has been given to several species which are listed below. In a similar but official manner Government in recognition of his long and faithful service awarded him the British Empire Medal in 1956.

During his last few years of service he suffered increasingly from breathlessness, but he refused steadfastly to take life more easily. He maintained that if he stopped working he would quickly die. Since there was no immediate replacement for him and since he lived solely for his work it was to his and to the Gardens' advantage that he stayed in harness. Even during the Muslim fasting month (Bulan Puasa) of 1958, which period to younger men in the best of health is deemed a test of moral and physical endurance, he refused to consider any adjustment of his working hours. His objection was simple: he did not want to be different. But in fact he was different in so many ways of punctilious honesty towards his work. A single example will serve to show his faithfulness. During the final fortnight of the Japanese military onslaught against Singapore in 1942, when all was sudden death, chaos and confusion, and again in 1945 at the time of the collapse of the Japanese hegemony, the office attendance register shows that Mohamed Nur reported with regularity for work, and at the height of these periods of the subordinate staff only he and his life-long colleague 'Che Ahmad bin Hassan signed in.

In his private life there is little to record for his work was his life. On 9th September, 1919 he married 'Che Fatimah binte Ariffin, in his only marriage by which there were six children, three sons and three daughters, all of whom survive him. In 1949 he made the Hadj pilgrimage to Mecca and to other holy places of Arabia.

His death was quite sudden and peaceful on the evening of 7th November, 1958. He came to work as usual, but at midday collapsed and was taken home. There he ate a little, then settled down to sleep, and that was the end.

In botanical history there are many instances of father-son successions. This inheritance of similar interests and abilities would make an interesting genetical study, and here indeed is yet another. For the four years before Mohamed Nur's death his son, Mohamed Shah, had been working as a Plant Collector in the herbarium. During this time Mohamed Shah showed and developed the family trait of an untutored botanical taxonomic acumen. It must have been a satisfaction to the old man that his son was destined to follow his footsteps. Four months after his death Mohamed Shah was confirmed in the post.

Plants named after Mohamed Nur

Dioscorea nurii	.. Kunth in Engler's Pflanzenreich, IV–43, 1924 (Reduced to *D. kingii* Kunth).
Begonia nurii	.. Irmscher in Mitt. Inst. Bot. Hamburg 8, 1929.
Cryptocoryne nurii	.. Furtado in Gardens' Bull. S.S. 8, 1935.
Daemonorops nurii	.. Furtado in Gardens' Bull. Singapore 14, 1953.
Ardisia nurii	.. Furtado sp. nov. in this issue.

Mohamed Nur's major plant collecting expeditions

(No record is available of innumerable minor collecting trips and single day forays)

Date	*Locality*	*Accompanying*
1913–24 (annually, covering every month of the year except January)	Penang, Port Swettenham, occasionally to Klang	I. H. Burkill or alone
July 1914	Tampin, Negri Sembilan	—
June 1915	Pulau Tinggi, P. Tioman, Johore/Pahang	I. H. Burkill
November 1915	Pulau Terutau, S. Thailand	Md. Haniff
February 1917	Taiping Hill, Perak	Md. Haniff
December 1920	Salak & Sg. Siput, Perak	Md. Haniff
August 1921	Sibolangit, Sumatra East Coast	F. W. Foxworthy J. A. Lorzing
November 1921	P. Langkawi group, Kedah	Md. Haniff
June 1922	Tembeling, G. Tahan (south side) Pahang	Md. Haniff
s.d. 1922	G. Pulai, Johore	Kiah

After the war another attempt was made to train a berok and Ngadiman went to Kelantan again bringing back a young one. It grew however to be physically weak and with limitations of staff and restrictions of collection in the Federation of Malaya owing to the "emergency", the attempt has not again been repeated.

With the acquisition of these monkeys, Ngadiman was tied to their care and training. Soon after Corner had got his first one, Ngadiman accompanied Corner with it to Fraser's Hill with most encouraging results. When two others were bought Ngadiman would take one or the other out every day to the Bukit Timah forest for training, and thereby the botany of the hill became very considerably better known. In addition Ngadiman would take the monkeys out to help Corner in studying the flora of the fresh water swamp forest around Mawai and Sungei and Kuala Sedili.

One new species of plant has been called after him: *Eugenia ngadimaniana* Henderson in Gardens' Bulletin, Singapore 11, 1947.

As a result of Ngadiman's association with Corner over the collecting monkeys and Corner's keen interest in wildlife protection, it was natural that when botanical reserves, one of them the Bukit Timah forest, were gazetted and put under charge of the Botanic Gardens Department, Ngadiman should be connected with them. Daily exercising the monkeys at Bukit Timah, Ngadiman was available for supervision. He was appointed Ranger in 1937 and remained in charge of supervision of the reserves, firstly as Botanical Reserves, then from 1951 onwards as Nature Reserves till the time of his retirement when he held the rank of Head Ranger.

In mid-1956 advanced TB was diagnosed and the disease would not respond to treatment. He died on 24th September, 1958, at the age of 54 years.

Of his 11 children, two are employed in the Botanic Gardens to maintain the family connexion with botany. *H.M.B.*

Kwan Koriba

KWAN KORIBA was born at Aomori, in the north of Honshu, in the year 1882. As a boy he was educated in the Middle School of the neighbouring city of Hirosaki, to which he finally returned in 1954, and where he died, suddenly, on 15th December, 1957.

Koriba received his higher education at the University of Tokyo, where he graduated in 1907, taking his doctor's degree five years later. He was Professor at the University of Tohoku from 1915 to 1920, and then at the University of Kyoto. In 1942, at the age of 60, he retired from the latter post, and was appointed Director of the Botanic Gardens, Singapore, under the Japanese military administration. Returning to Japan early in 1946, he lived in retirement, continuing his botanical studies, until 1954, when he was requested to undertake the office of President of the University, in which office he continued until his death.

From his youth Koriba was interested in field botany, and in observing the behaviour of plants in nature; on such subjects he published several papers. He travelled extensively at various times, to Europe, North and South America, and nearer home to Micronesia and Java, taking the opportunities of such travel to widen his acquaintance with plant life. While at Tokyo, he began to devote himself to the study of environmental factors and their effects on plants, and in this utilized his considerable knowledge of physics; this work involved extensive research on transpiration and evaporation. He continued his interest in the relation of plant-behaviour to climate in Singapore, where he made records of the periodicity of growth and leaf-change in many kinds of trees. A summary of these observations has recently been published in Vol. 17 (1) of the *Gardens Bulletin*.

During his period of retirement from administrative duties, in 1946–54, he published two books, one on the forms of plants in relation to organization and function, and one on plant physiology and ecology. He planned a further book on the evolution of plants.

At Singapore he was given the rank of Brigadier-general, but wore the uniform of that rank only on ceremonial occasions. He devoted himself to his administrative duties and to his botanical studies. He was dependent on the military organization for funds and supplies of all kinds, and took every opportunity of securing such amenities as were possible for the gardens staff. On several occasions he took energetic action to prevent encroachment on the

Nature Reserves of Singapore, in which he took great interest. He was also greatly concerned that the herbarium and library at the Gardens should be maintained intact. To his single-minded devotion to botanical science the Singapore Botanic Gardens owes much.

He was a man that commanded respect by his simplicity of life and unfailing devotion to his duty, by his very broad scientific outlook, and also by his sympathetic understanding of human nature, an understanding that transcended racial boundaries, even in time of war and of privation. *R.E.H.*

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